Editorial

IN wishing our readers a Merry Christmas and a Happy New Year, there is no necessary connection with the fact that this is likely to be our last non-TV Christmas period!

It is highly likely that some programs will be available before the end of 1956.

There should be, and there must be, every reason to expect our lives to be the better for them.

It is an appropriate period to consider again the influence of TV on the children, for Christmas is essentially a children's time. It centres around a child born nearly 2000 years ago.

Let us look at some conclusions reached by factual surveys, published in overseas journals.

Selecting some vital points, it is claimed that the 6-10 year group watched TV the most. In this group, 50 pc were emotionally disturbed by what they saw, girls much more than boys. Fifty-nine pc stayed home more, 53 pc read less, 24 pc made fewer things with their hands, 13 pc played less.

Parents said that most programs were grossly inappropriate for children and gave them a fantastic and unreal picture of the world. Serials were not nearly as scary as old-time Saturday matinees. Could cowboys still be cowboys and have presentable table manners? Exposure to a reasonable amount of TV increases vocabulary, word recognition, general knowledge and understanding. The casual display of crime, sex and anger is an insidiously evil force. A few crime pictures show what the police force is doing and are not as bad as reading about crime in the papers.

Now all these things are applicable in various degrees to other influences our children will experience and adjust themselves to meet. We can no more keep the unhappy side of life from them than we can avoid it ourselves.

But we can and we must control TV to make good use of its tremendous impact.

That 6-10 year group is pitifully susceptible to building fantastic and unreal pictures. It is just as susceptible to increasing general knowledge and understanding. TV can teach, for good or bad, more in half an hour than can be retained from a full volume of reading.

We cannot over-emphasise the importance of TV to the children who in a few years will be carrying the national burden. No selfish interest must be allowed to waste its power, to weaken our enterprise, or to create emotional problems it cannot solve.

Out of all this, I think we can build some worthy resolutions for the New Year.

John Moyle

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RADIO TELEVISION & HOBBIES

A NATIONAL MAGAZINE OF RADIO, TELEVISION, HOBBIES AND POPULAR SCIENCE

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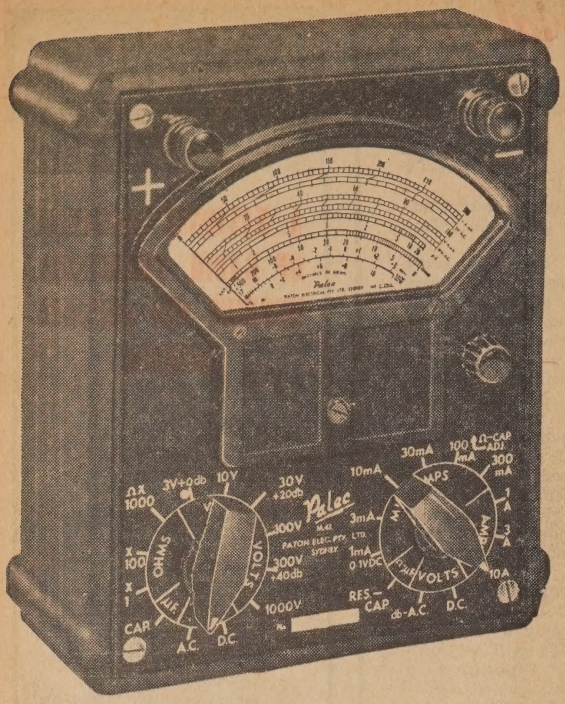
OUR COVER PICTURE

Loading a Nike guided missile and its launching platform into the spacious cargo compartment of the new turbo-prop Hercules. The enormous aircraft can also cope with a 5000 gallon petrol tank truck and a 155 mm howitzer plus paratroopers. (Pictures page 3).



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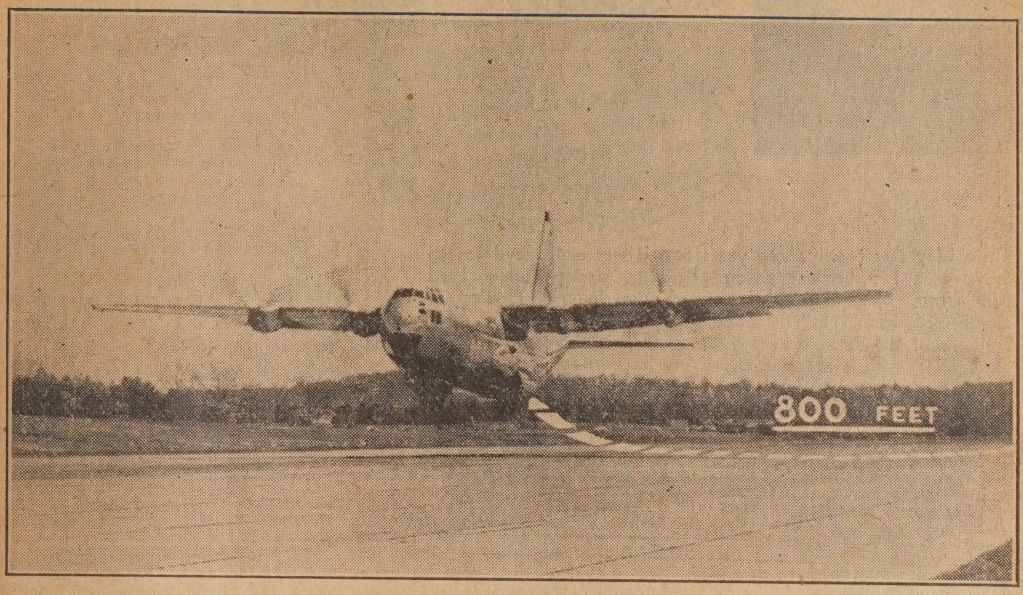
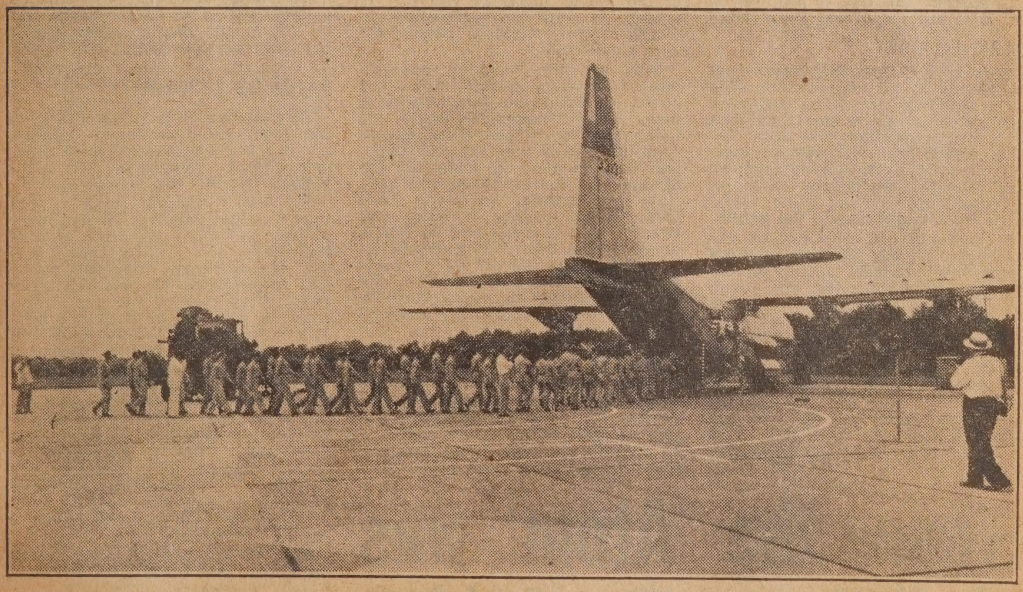
MIGHTY HERCULES LEAPS FORWARD



Taking off in remarkably short distance of approximately 800 feet is the new US Air Force Hercules C-130 transport in a production test flight. The new four-engine turboprop has a total of 15,000 horsepower available at take off. Although the plane in this picture is not loaded to the maximum, the Hercules can take off at a gross weight of 108,000 pounds.



During first public demonstration of the new transport, 92 troops march into a single Hercules turboprop. The aircraft, designated a "medium combat transport," ushers in a new era of global mobility for the Tactical Air Command of the US Air Force by providing means of moving men and material anywhere on earth at short notice.

FEAT OF BRITISH SCIENTISTS

TRANSFORMATION OF ELEMENTS

THE atom has been split and elements have been transformed into other elements.

This wonder, the dream of years of [illegible]

THE MIRACLE OF CREATION

U.S. REPORT ON CAMBRIDGE TESTS

Lord Rutherford's View

From F. C. PRINCE-WHITE

CAMBRIDGE, Tuesday.

PERHAPS the greatest penalty that scientists have to pay for possessing knowledge of th[illegible] beyond the range of co[illegible] is that [illegible]

On a May day twenty-three years ago it was announced to the world that two brilliant young physicists, working under Lord Rutherford, Cavendish Professor of Experimental Physics at Cambridge, had "split" the atom. One of them was the present Director of the Atomic Energy Research Establishment, Sir John Cockcroft; the other was Dr. E. T. S. Walton, now Erasmus Smith Professor of Natural and Experimental Philosophy, Trinity College, Dublin.

When the Atom was "Split" at Cambridge

By F. C. PRINCE-WHITE

THEIR great achievement, the dream of scientists for many years, was the culmination of years of patient experiment at the famous Cavendish Laboratory, Cambridge. At the same time they realised an age-old hope of alchemists in finding a way of transmuting matter; they turned atoms of hydrogen into helium.

The news flashed around the globe with the urgency of tidings of first importance to mankind. Here, indeed, was a scientific story not for scientists only but for ordinary folk everywhere. It fell to my lot to tell it to readers of the Daily Mail.

DARK MYSTERY

This was a task that seemed at the outset to be almost impossible of accomplishment. The structure and behavior of the atom had long been a dark mystery, and there had been many and violently conflicting theories concerning it. How, then, was this stupendous matter of the "splitting" of the atom to be made reasonably clear to the public?

I saw only one way out of this difficulty: it was to talk to Lord Rutherford himself. I hurried off, therefore, to Cambridge, and found the great man at home, in his study. I told him that the news of what had happened in the Cavendish Laboratory had no doubt thrilled scientists all over the world—but it had made ordinary people uneasy and anxious: they were wondering whether the "mighty atom" they had heard of had been discovered to be as powerful as had been suggested, and they would want to know whether it was likely to turn out in the future a good deal mightier than it was known to be already.

He smiled at this, and said he doubted whether it was possible to explain in general terms what had been done; and as for what it was likely to lead to, nobody could tell.

The situation appeared rather desperate. "Sir," I said, "please try to tell me as much as you can as simply as you can—preferably in words of two syllables. Regard me as a small child."

This set him laughing uproariously. Presently he said, "It's a tall order, but I'll do my best." He must have done triumphantly well, for he enabled me to form a sufficiently clear picture of how the "splitting" was brought about to make the job of reporting the event not only possible but exciting. Such was Lord Rutherford's lucidity of mind and friendly charm that when he talked to me of the theory of wave mechanics, and the "birth" of electrons through the action of radiation, the subject seemed an extraordinarily fascinating one even to my unscientific perception.

SCENE OF THE "SPLIT"

Later, I paid a visit to the scene of the "great split". Being admitted to the Cavendish Laboratory was like entering some magic chamber. In a dimly-lit, lofty room I saw a phantasmagoria of giant glass tubes which towered almost to the ceiling. At a small bench in a corner sat a young man who gave me a serious but friendly glance through his spectacles. His right hand, I remember, rested on an electric switch. He was Dr. Walton.

This magician experienced some difficulty in answering my rush of eager but inexpert questions. I fear most of them must have appeared extremely fanciful to him, for I was far too quickly expecting world-shaking wonders to develop from the feat in which he had shared.

He pointed out that experiments would have to go on for years, but he left me to imagine what secrets the atom yet concealed.

RAPID DEVELOPMENT

As a matter of fact, the attack on the atom developed very rapidly, and in a few weeks atoms were being split almost every day. The marvellous became the commonplace.

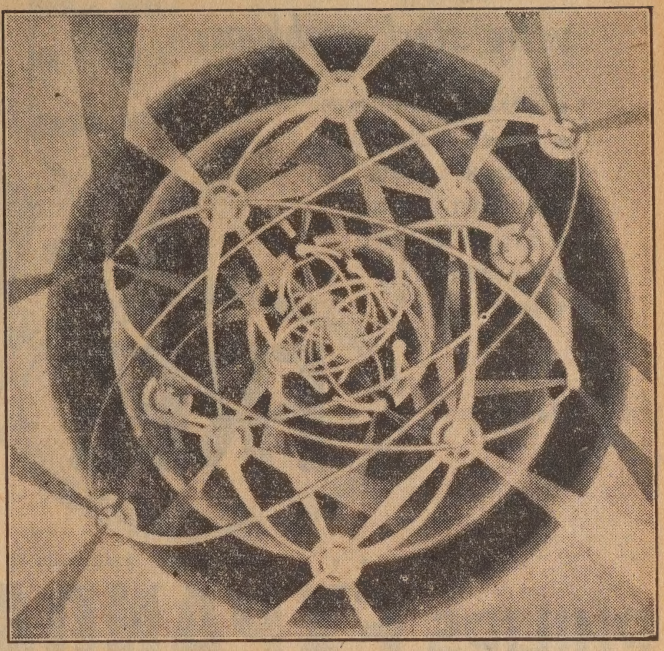
Sir John Cockcroft's view at that time was that although the discovery of how to "split" the atom was of immense scientific importance it was not of immediate practical value. But nevertheless he was obviously seeing very clearly into the future when he said, "If an economic process is developed I believe it will be along the lines of this research."

Judging from statements he made publicly more than a year after the Cockcroft-Walton achievement Lord Rutherford was not at all sanguine about the possibilities of early practical benefit from it. At a meeting of the British Association in the autumn of 1933 he said, "Anybody who expects a source of power from the transmutation of these atoms is talking moonshine."

That he was certain, long before the event, that the line of research which he and his assistants were pursuing would lead to a method of "splitting" the atom was indicated by his assurance in 1927 to the Royal Society, of which he was president, that "knowledge of the atom

THE PRIVATE LIFE OF THE ATOM

No kind of formal introduction to an atom can be arranged because no one has ever seen an atom and as far as can be foretold the prospects of seeing one are very remote. Just how small is an atom? Supposing there were available a very small and industrious demon who could be sent out to collect a million atoms and then lay them side by side on a sheet of paper. At the end of this labor he would have produced nothing that could be seen.



An artist's impression of the electrons revolving around the nucleus of the atom.

LET it then be required of the demon to go out again and for each one atom already collected to collect another million. Suppose these be then laid out as a strip a hundred thousand atoms wide and 10-million atoms long. After this herculean labor it would then be possible to see a very faint strip the thickness of a piece of cigarette paper and one-tenth of an inch long.

It could be thought that in view of the very small size of the atom, that any attempt to describe it or try to investigate its behavior would be doomed to failure. On the contrary, scientists can produce quite remarkable evidence to support their theories of the structure of the atom; they can influence the behavior of individual atoms and can photograph their tracks in a cloud chamber.

PROGRESS OVER 60 YEARS

In the days of the old philosophers some two thousand years BC men were even then discussing how particles of matter are built up. They did not do any experimenting in those days, no putting opinions to the test. Only argument was acceptable and the better you could argue the higher was your reputation. What they argued about was just this — all matter must be continuous like a sea of water (or like a jelly) or else it must be made up of many fine grains, like sand (or like peas in a peck).

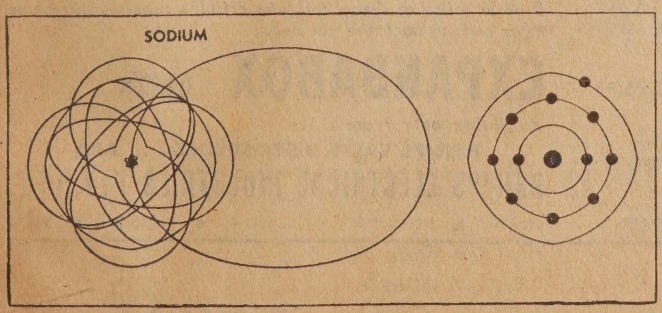
A good deal of progress has been made since those days, and most of it has been crowded into the last sixty years. In very recent days the atom has assumed a great deal of importance in our lives, and many people are still engaged in trying to get better acquainted with it and understand its reactions in different circumstances.

A simple description is not an easy task because the atom has quite a complicated structure. At its centre is what is called the nucleus and this is the heavy part. Round it revolve the lighter electrons which at one time were thought to be little bits of matter charged with negative electricity. They are regarded as pure units of electricity. They are the ultimate bricks of which all matter is built, but they are rather elusive.

An electron cannot be pinpointed. It is thought of as a cloud and where the cloud is densest there is the best chance of locating an electron. These electrons revolve round the nucleus in a limited number of possible orbits, and as they revolve they spin.

They are arranged on a number of imaginary shells. Two and two only, electrons are found on the first shell. On the next shell the highest possible number of electrons is eight, on the one outside that the number is eighteen, and beyond that again the possible number is thirty-two.

One curious thing about these numbers which needs only to be pointed out to be appreciated is, that if the numbers one, two, three, four, &c., are taken then the double of their squares will be 2, 8, 18, 32 and they have been referred to as the Magic Numbers.



DIFFERENT ENERGIES

The diagrams given are intended to emphasise the fact that the electrons at different distances from the nucleus have different energies. It can happen that an electron will move from one shell to the next inner one and when this occurs energy in the form of heat and light is produced. Atoms can be made to give out light if they are "knocked about" rather vigorously as by heat-

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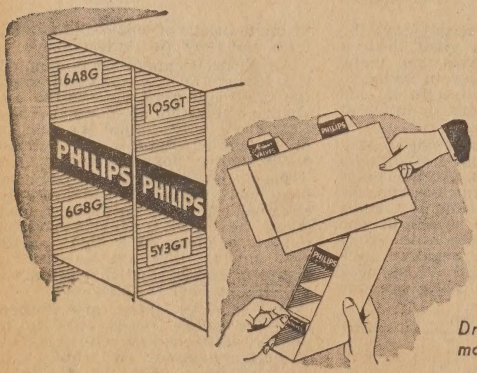

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ing them strongly or by electrical means.

Most people are familiar with examples of such things but probably do not know the explanation. If a little salt is thrown into the gas flame on a cooking stove the flame immediately becomes tinged with yellow which is the characteristic light given out by sodium atoms. The well-known reddish light called "neon" light is produced from neon atoms confined in a tube through which an electric discharge is passed. The diagrammatic representation of the sodium atom depicting the number of electrons on each shell is not to be taken literally, for after all the electrons are in motion.

The Bohr plan of the electron orbits given alongside for the same atom was an improvement on the first over-simplified diagram, but has itself been superseded. It does, however, emphasise one important fact that the electron on the outer shell is a rather privileged one. It is in fact this one that takes part in and is responsible for the chemical reactions of the element sodium.

THE NUCLEUS

The electrons buzzing around the nucleus form a strong guard and only the most drastic means are likely to be successful in helping us to get acquainted with the nucleus. If protons or alpha particles, both of which are positively charged, are introduced politely, that is at low speeds, to the nucleus, the latter repels them.

It is only with the greatest persistence using high-speed particles, that there is any chance that a collision will occur. And by high speed is meant speeds of thousands of miles per second. With a neutron the introduction is easier, because it is neutral and is therefore not repelled. Nevertheless, it requires considerable energy to penetrate the electric field surrounding the nucleus and so moderately fast moving neutrons must be used but the chances of collision are enhanced. In the bombardment of most elements by neutrons the nucleus can absorb the neutron and the extra energy it carries.

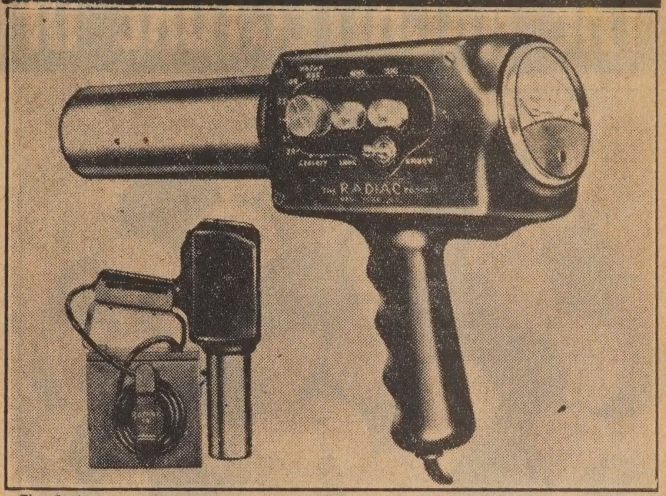
The atom is then transformed into an isotope. Quite often this isotope is unstable and it gets rid of its extra energy by giving out certain types of penetrating radiations. In this condition it is said to be radioactive, and today a good many artificially produced radio-active isotopes are being prepared and put to useful service in industry, medicine and science.

DREAM COME TRUE

In medieval days men sought vainly for the elixir of life which would prolong human life indefinitely, and for the philosopher's stone that would change base metal into gold and so enrich all who knew the secrets. Now the philosopher's dream has come true, and one metal can be transmuted into another, but the transmutation is not directed to the production of gold for that would be unprofitable.

The enormous amounts of energy that are usually associated with the term of "atomic energy" are not produced during the normal life of the common atoms. It is only with certain elements, the heavier ones, and under certain conditions that the life of an atom can be completely disrupted.

TRANSISTOR GOES PROSPECTING



The Radiac Company of 489 Fifth Avenue, New York City, is introducing a new line of transistorised prospecting instruments for use in locating uranium, thorium and oil. The instruments, which have just completed extensive field evaluation trials, include one transistorised scintillation counter, the "Transcintillator", and three different Geiger counter models, the "Geiger Gun" Marks I, II and III.

The "Transcintillator" which also incorporates the popular gun-type construction, can be used with any of three interchangeable "barrels", containing a 1½" x 1", 2" x 2", or 3" x 3" crystal as the detecting element. It is suitable for airborne as well as vehicular and foot surveying, and features greatly reduced power drain with consequent longer battery life, smaller overall size, and substantial savings in cost over vacuum tube instruments.

The "Transcintillator" with the plugin "gun-barrel" containing a 1½" x 1" crystal is shown in the photograph.

WHEN THE ATOM WAS FIRST SPLIT

(Continued from Page 4)

would no doubt be clarified within the next few years."

His preoccupation with the mystery of the atom was purely and entirely scientific. I do not think he cared considerably whether the knowledge gained from solving it proved, or did not prove, of practical worth. He once said, "I know of no more enthralling adventure of the human mind that this voyage of discovery into the almost unexpected world of the atomic nucleus."

For some years prior to the "splitting" of the atom the question of atomic research was both hopefully and fearfully discussed. Many books were written about it, and newspapers gave much space to letters and speeches concerning atomic energy.

"If we can harness this power,' wrote one enthusiast, "almost all our material difficulties are at an end." "Quite apart from the transmutation of elements," said a professor of mathematics, "consider the effect on our economic and social structure of being able to produce enough energy from a lump of sugar to blast a hole in the earth as large as Vesuvius. Who would want coal? Who would want oil?"

FLASH OF PROPHECY

Professor Leonard Hill, in 1928, estimated that the annihilation of a single drop of oil would release sufficient energy to propel the Cunard liner Mauretania across the Atlantic, and that the annihilation of one pound of coal would produce as much energy as the combustion of 5-million tons.

Britain, the United States, Russia —all were seeking the secret of the atom, and in many parts of the world deep anxiety was expressed regarding the possible effects of releasing the atom's unknown energy. "It might prove so terrific as to detonate every other atom," an expert in chemical physics contended; and another seriously suggested that the result might well be to transform the earth into a new star!

In a flash of prophecy whose truth was to be established more than twenty years afterwards, Bertrand Russell warned in 1923 that the mounting knowledge of the atom would "ultimately be used for making more deadly explosives and projectiles than any yet invented". In 1945 the first atom-bomb exploded over Hiroshima.

In 1921 the Daily Mail published an article which referred to advances in atomic knowledge, and commented, "We may expect discoveries greater than the discovery of radium and of more general application."

How widely applicable those discoveries have already proved!

THE ARCHITECTURE OF THE ATOM

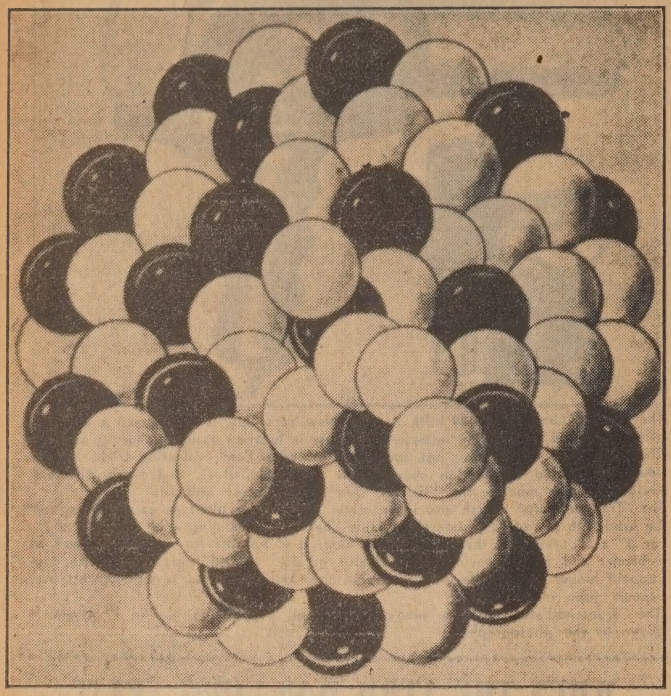


Fig. 2—An assemblage of neutrons (white) and protons (black) for the elements cadmium. It illustrates the fact that with atoms of the heavier elements there are more neutrons than protons.

The word atom is derived from two Greek words which mean "uncuttable" or "indivisible", and refers to the grain structure of matter. Since it is not easy to visualise matter being continuously divided and sub-divided until some kind of ultimate indivisible particle is obtained, we can perhaps think of a very tiny particle of matter—a mere speck of dust—being so magnified that eventually we would be able to see the construction revealed.

THIS way of looking at the matter had been considered by the Ancient Greeks. Some of their philosophers had contended that matter was granular and would look like the sands upon the sea-shore, while others asserted that matter was continuous and would look like the waters of the ocean.

But neither the one school of thought nor the other produced any real evidence to support their contentions.

JOHN DALTON

It is an interesting study, though hardly appropriate to the present purpose, to follow the development of the theory of atoms right down to the time of John Dalton. Dalton, who has been called the father of chemistry, was the first to propose a truly Chemical Theory, which satisfactorily co-ordinated the known facts of chemical combination. It must, however, be emphasised that his theory did not attempt to explain anything about the nature of the atom, and indeed the matter did not seriously arise until about one hundred years later.

The atoms of different elements, according to Dalton, differed only in size and weight. They were frequently regarded as little spheres that could not be changed by any known agency—they were indeed made at the beginning of time and would remain unaltered until the final dissolution of the world.

But we now know that an atom has quite a complicated structure and can be altered by suitable agencies; in fact certain atoms have been slowly undergoing change during thousands of years. Dalton's pictures of the different atoms were small circles, each having its own distinctive mark within the circle. They were invented mainly to facilitate the understanding of his theory. Compounds were represented by placing the appropriate atoms side by side. No attempt, however, was made to explain what were the forces involved in holding the atoms so firmly together. It was assumed that certain elements had an "affinity" for one another and there the matter was allowed to rest (see figure 1).

The first step in the elucidation of the structure of the atom was made less than 60 years ago, when the electron—the "atom" of electricity—was discovered. This discovery resulted from an investigation of the cathode rays. These are the particles that are shot off from the cathode when a current of electricity is passed through a tube containing a gas at a very low pressure.

The particles, or electrons, travel at very great speed, and when they fall upon certain substances called phosphors, the latter are caused to glow brightly. This effect is used to produce the picture on the television screen. If the electrons are allowed to impinge upon a piece of heavy metal, contained in the tube, they give rise to x-rays.

NEGATIVE ELECTRICITY

Now it has been shown that these electrons are not to be regarded as small particles of matter charged with electricity, they are in fact pure negative electricity. Electrons can be obtained from any kind of matter.

They can, for instance, be detached from atoms of metals by heating the metals, or by allowing x-rays or ultra-violet light to fall upon them. Many light sources produce some ultra-violet light so that this latter effect is used in what are called "photo-electric cells", which can be used to control certain mechanical devices such as the opening and closing of doors as one approaches them, and on the sound track of certain cinema film.

Electrons are much lighter than even the lightest known atom. An atom of hydrogen is 1,840 times as heavy as an electron. This latter is now known quite definitely to be a constituent part of the structure of all atoms. The actual number of electrons in an atom depends upon the nature or kind of atom.

And since the atom as a whole is normally not electrically charged—in other words it is neutral—each atom must also contain a positive charge sufficient to neutralise the negative charges of all the electrons. The whole modern conception of the structure of the atom is primarily concerned with the number and arrangement of the electrical charges within it.

HEAVY URANIUM

Now an atom of uranium is known to be about 238 times as heavy as an atom of hydrogen, and it contains 92 of these very light electrons. It is therefore obvious that the electrons cannot account for the whole weight of the atom. There must be some more massive and heavier part with which the positive charges

would be associated. This heavy part we call the nucleus.

Around the nucleus the electrons are arranged in a more or less orderly manner, and the whole structure has been likened to the solar system, the nucleus representing the sun, and the electrons the planets. This makes a convenient picture though perhaps neither a very complete nor a very accurate representation. Indeed a more extensive knowledge of the nature and behavior of the electron has made it necessary to discard the conception of precise mechanical orbits for the electrons.

The electrons are arranged in groups, each group being distinguished from the others by its average distance from the nucleus, and revolving round this latter on the surface of an imaginary sphere.

ELECTRON MOVEMENT

The electrons on the outermost of these concentric spheres are the ones that are concerned in chemical changes. Thus when iron rusts or carbon burns, it is the electrons on the outside of the iron or carbon atoms that, together with the electrons on the outside of the oxygen atoms of the air, become involved in the formation of a molecule of rust or of carbon dioxide. The discovery of the electron must therefore be regarded as one of the most outstanding accomplishments of modern science, and the measurement of the electrical charge that constitutes the electron is of both theoretical and practical importance.

All electric currents are caused by a procession of electrons along the conducting wire or rod; all light —which is short wavelength radiation—is caused when electrons of one of other of the groups within the atom change their position; all chemical actions are the result of attractions of positive and negative charges; all elastic forces may be regarded as due to the attractions and repulsions of electrons inside the material.

Fundamentally all matter is electrical in origin.

No one has ever seen an atom, because of its exceeding smallness in size. And there seems to be little prospect, even with all the present inventions of science, that we shall ever be able to render visible to the human eye a particle so small that a hundred million of them placed side by side would measure only one inch. A small particle of dust probably contains a thousand million million atoms. Such figures are really quite beyond our comprehension.

PROPERTIES OF ATOMS

Let us then try again by supposing that an atom could be so magnified that the nucleus would be the size of a golf ball. The distance across an atom of uranium would then be rather more than one-third of a mile. Such a conception helps us to realise that after all the atom is mostly empty space. It should be a matter of no little amazement that in dealing with a thing so minute as an atom it has been possible to learn so much about its component parts and their behavior in certain circumstances, and about its general structure.

Our experiences with matter, such as what happens when we heat it in a fire, hammer it or pour acid upon it, have enabled us to appreciate the ordinary physical and chemical properties of the atom. But it is only recently that we have come to know that these properties are dependent upon the constitution of the electron cluster and upon the way his can be influenced by outside agencies.

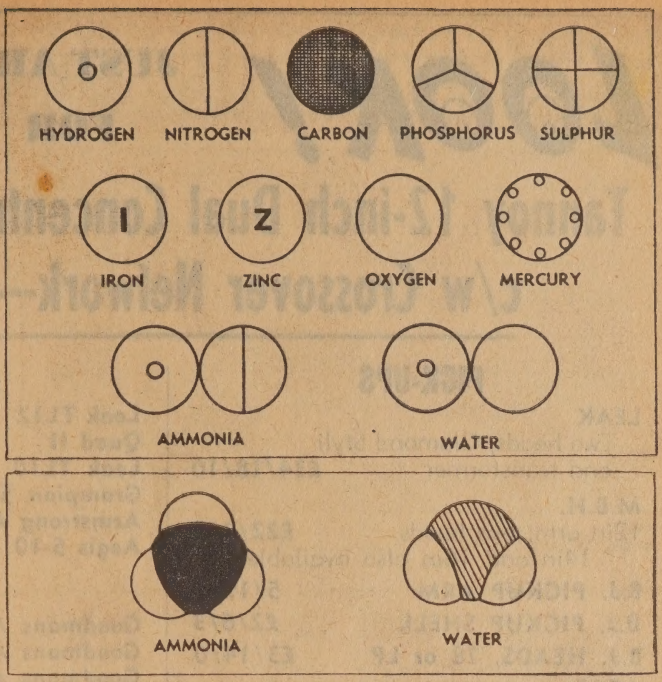


Fig. 1—The top sketch shows Daltons symbols representing atoms and molecules. The lower sketch shows the modern models of molecules.

There are other properties of the atoms, that are dependent upon the movement of electrons from one group to another, and still other properties that we include under the description "radioactivity", which are associated with the structure of the nucleus. These latter properties are quite independent of all other properties.

The nucleus of an atom is quite a complicated affair. It consists of an assembage of neutrons and protons that are held together by so great binding forces that any change in the nucleus structure involves enormous amounts of energy change.

The proton is about 1840 times as heavy as the electron and each one carries a positive electric charge of an electron. The commonly used expressions "the atomic number of an element" is really no more than the number of protons in the nucleus of the atom. This is also the number of electrons that encircle and guard the nucleus. A neutron has about the same weight as a proton but does not normally exhibit either a positive or a negative charge.

What holds the protons and neutrons together is something of a mystery still. In the figure (2) is shown an assemblage of neutrons (white) and protons (black) for the element cadmium. The sketch does not of course attempt to represent any actual arrangement, for indeed we do not know what arrangement exists, but it does illustrate the fact that with atoms of the heavier elements the number of neutrons is much in excess of the number of protons. In the case of cadmium there are 48 protons and some 64 neutrons.

It is interesting to note that the weight of a nucleus is less than the total of the weights of the separate protons and neutrons. It is supposed that the particles are packed so closely that some of the weight disappears and reappears as energy. The energy exchange associated with the disappearance of a very small amount of matter is extremely large.

STABLE NUCLEUS

The nucleus of a lead atom contains 82 protons and when these are associated with 124 neutrons a very stable nucleus is formed. All atoms having more than 83 protons in the nucleus are unstable, which is the same thing as saying that they are naturally radioactive.

Radioactive elements of this kind lose electrons and alpha particles until finally an atom of lead is formed. Then no further change occurs. This process is called "decay" and it takes place in stages, the completion of each stage occupying a certain

NEXT MONTH — The actual smashing of the atom will be dealt with in next month's articles in this series on nuclear fission. All the authors are men famous in their field.

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time, which cannot be shortened or increased by any means in our power.

An atom of uranium breaks down naturally of its own accord and very slowly. The radioactivity of any piece of uranium will be reduced by only one half after more than four thousand million years. This period is called the half life of uranium. In something approaching five thousand million years one half of a piece of uranium will have become changed into radium.

In the same way after little more than 1700 years one half of the radium will have become changed to lead. It is very important to note these very long half lives. If they were not so great all the uranium in the world would have changed into lead during the course of the world's history.

PROPORTION OF LEAD

Of course lead is always found associated with uranium, and by finding the proportion of lead to uranium in an ore it has been possible to make a guess at the age of the earth. It can only be a guess because it is not known what, if any, substance was the parent element of uranium.

In the diagram (3) an attempt is made to illustrate the process of radioactive decay. The figures along the bottom of the chart represent the numbers of neutrons in the nucleus, and those along the sides represent the number of protons in the nucleus of the different atoms. Ordinary uranium 238 is shown having 92 protons and 146 neutrons. Any other atoms having 92 protons in the nucleus would be shown on the same horizontal line, since of course they would all be isotopes of the same element.

Moving downward from any point means the loss of protons, and moving to the left means the loss of neutrons. When a nucleus shoots out an alpha particle (that is 2 protons and 2 neutrons) the position for the new substances is found by moving two places downwards and two places to the left. In that way will be found the position of uranium X1, which is an isotope of thorium.

CLOSE PARTNERS

Some nuclei shoot out beta particles which are really only electrons. Since the nucleus does not contain electrons some explanation of their origin is clearly called for.

It is generally accepted that a neutron can be regarded as a very close partnership of a proton and an electron. So when a beta particle is shot out a neutron must disappear and a proton will remain. To find the position of the new element it is then necessary to move one place upward (because there is one extra proton) and one place to the left because a neutron has been lost.

In this way is found the position for uranium X2 which is an isotope of tantalum. In each case the half life of the change is stated, and the whole diagram represents what is called the Uranium Series. All the different substances produced are solids with the exception of radon which is a gas. This quickly deposits upon any surface with which it comes into contact, depositing a white substance known as radium A.

During decay, radioactive substances give out heat. In the whole of its lifetime one ounce of radium gives out as much heat as could be obtained from the burning of ten tons of coal. This is undoubtedly a large quantity, but what a time you would have to wait to get it. The diagram also indicates that at certain stages gamma rays are given out. These are very penetrating rays which are destructive to animal and vegetable tissue and they affect a photographic plate. They are so penetrating that they can pass through as much as six inches of solid steel. Because of this, these rays are used to discover defects in steel castings by photographing on to a special film.

PROCESS OF RADIOACTIVE DECAY

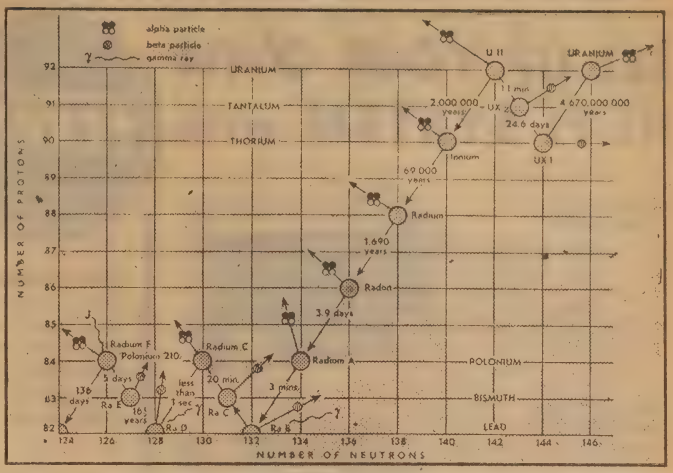

Fig. 3. Illustrating the process of radioactive decay. The bottom line represents the number of neutrons and those along the side line the number of protons, in the nucleus of various atoms.

MODERN AIRCRAFT WINGS ARE STRONG

STRIKING advances made in aircraft production technique have been spotlighted by recent announcements by two manufacturers—Boulton Paul and Handley Page — concerning wing construction.

Conventional wing structure used in slower aircraft—permits a certain amount of flexing under load, and this causes skin wrinkling. Modern high-speed aircraft, however, demand wings that retain their accuracy of contour under great stress, yet which must, in the interests of aerodynamic efficiency, be thin.

FOR HIGH SPEED

This can best be achieved by using a thick skin of either solid or sandwich construction, though, inevitably, this leads to a reduction in the space available for internal structure.

Boulton Paul tackle this problem by means of solid "integral" construction, and a wing built on these lines achieved a thickness-chord ratio of only three pc; that is to say, the thickest vertical depth is approximately 1-33 of the average distance from the leading to the trailing edge—one of the lowest ratios yet recorded.

The wing halves are made up of 12 light-alloy elements that form the upper and lower surfaces. Each element consists of a spanwise spar which has a section of the skin surface as an integral part of it. Six of these members connected together form the top or bottom half of a wing and are fixed to their opposite numbers by means of specially formed bolts. The resulting multi-spar, thick-skinned wing possesses a high degree of solidity, which dispenses with the necessity for rib members.

Handley Page have approached the problem in a different way. They decided that double skins of relatively thin gauge with a sandwich construction in between, would provide a light, strong, and, from the production standpoint, easily handled wing structure that would stand up to the arduous conditions imposed by very fast, long-distance flight.

USEFUL MATERIALS

Various kinds of sandwich materials have been used, both before and since the last war. One of the first examples used in prewar days had a fuselage made partly in this way. Balsa wood, foamed resin, honeycomb or corrugated metal, and plastic have all been used between light alloy or plywood skins.

Handley Page found that the most suitable form of sandwich construction was a longitudinally-corrugated sheet of aluminium alloy attached to the inner skin by rivets and to the outer by spot welding.

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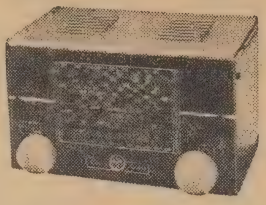
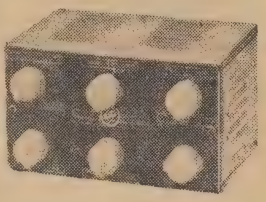
HIGH FIDELITY RADIO TUNER



Has frequency coverage of 530 to 1,620 KC/S. Incorporates a 10KC/S whistle filter and special low distortion detector circuit. Large perspex dial calibrated for all Australian States and in metres and kilocycles.

EQUALISER PRE-AMPLIFIER UNIT

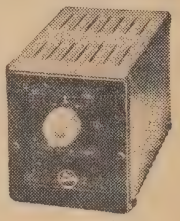


Extremely wide flexibility of control is afforded over the entire musical spectrum, providing innumerable combinations of tonal balance. Six controls are utilised, viz., a 5-position record equalising switch for all makes of records, a radio - records switch, a treble rise-treble fall switch, a volume control, a treble control, and a bass boost control (both continuously variable).

POWER AMPLIFIER UNIT

Incorporates highest quality output transformer with 17 db inverse feed-back loop from secondary to amplifier input. Stable, low noise, straightforward amplifier with a completely flat frequency response from 15 to 15,000 cps. Negligible harmonic and intermodulation distortion.

LOW PASS FILTER UNIT



A "top cut" filter for eliminating intermodulation distortion and/or surface hiss from worn or poor quality recordings when played either at home or broadcast on the radio programmes. Designed to provide a sharp cut-off characteristic at 2 cut-off frequencies, viz. 6 KC/S and 8 KC/S plus a third position in which the filter is switched out of circuit to utilise the full range linear frequency response characteristic of the amplifier.

TECHNICAL SUMMARY

Output frequency response of complete system from input to output 20 cps. to 15,000 cps. + or — 1 db.

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Hum and noise level — 60 db below output.

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Degree of bass boost at 50 cps. relative to 1KC — 19 db.
} Continuously variable.

POWER SUPPLY UNIT: Comprises a centralised power supply for the Ferris Hi-Fi Home Music System (or any other suitable equipment) and provided with sockets for plug-in cable attachment to the other units. A 6-volt A.C. outlet is also provided for external panel illumination, etc.

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WILL FRESH AIR BE OBSOLETE?

Year-round air-conditioning systems shown here are GE's heat pump which uses only electricity and air, Carrier's "Weathermaker" which cools electrically and heats with oil or gas, and Servel's all-gas model.

Air conditioning for private homes isn't yet popular in Australia, but some day it will be. In the meantime, these pictures show some of the latest ideas used in American homes, where hot and cold systems are building into a big business.

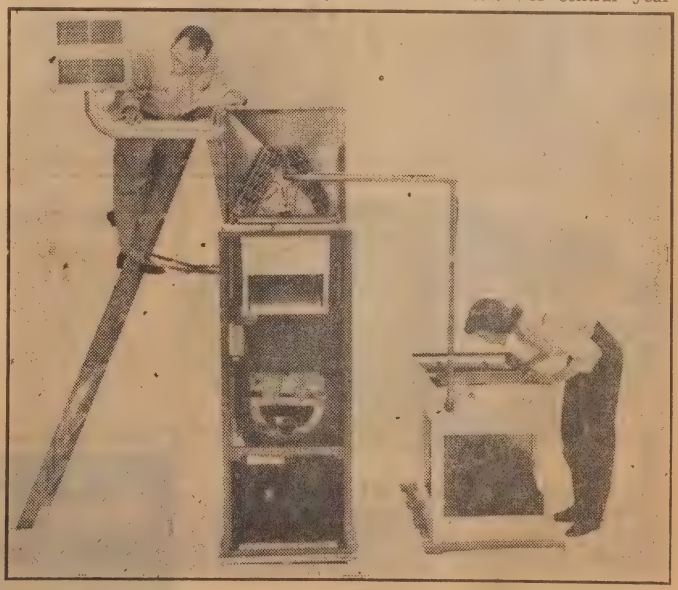
EVERYBODY is still talking about the weather, but nowadays plenty of people are doing something about it.

About 1-million American families will add some form of air-conditioning to their homes in 1955—and total retail sales by the industry for the year are heading for a record 2¼-billion dollars.

Spearheading the advance of the industry is year-round central air-conditioning for the home. With a potential market almost as vast as the number of houses in the US, sales of central air-conditioning units — which cool in summer, heat in winter —are expected to double last year's total.

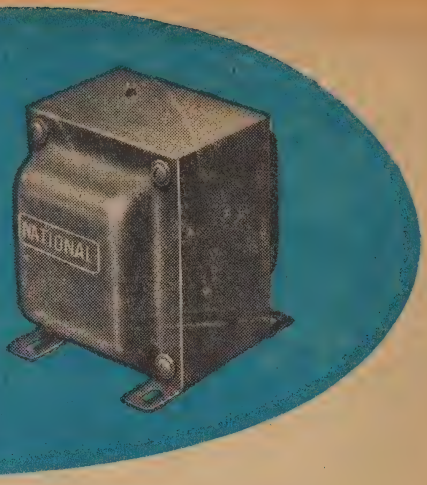
Since the first perspiring husband patted the rump of a room air-conditioner in place and found he could sleep at night some form of central air-conditioning for homes has been almost inevitable. The new all-season units do more than just cool or heat the air. They control moisture content, circulate the air and clean it.

These side advantages help cut down on the housework. A survey of 22 test homes in Austin, Texas, showed that housewives with air-conditioned homes saved 22 dusting hours a month. A central year-



Modern high-pressure furnace with add-on cooling unit features small space-saving ducts. The condensing unit, right, is located outdoors.

National POWER TRANSFORMERS



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U or F40/285	"	40	285/285	6.3v/2a 5v/2a	Upright or Flat
U or F40/325	"	40	325/325	" "	Upright or Flat
U or F50/225	"	50	225/225	6.3v/2a	Upright or Flat
U or F60/285	"	60	285/285	6.3v/2a 5v/2a	Upright or Flat
U or F60/325	"	60	325/325	" "	Upright or Flat
U or F60/385	"	60	385/385	" "	Upright or Flat
U or F80/285	"	80	285/285	6.3v/2a 6.3v/2a 5v/2a	Upright or Flat
U or F80/325	"	80	325/325	" " "	Upright or Flat
U or F80/385	"	80	385/385	" " "	Upright or Flat
U or F100/285	"	100	285/285	6.3vct/2a 6.3v/2a 5v/2a	Upright or Flat
U or F100/325	"	100	325/325	" " "	Upright or Flat
U or F100/385	"	100	385/385	6.3vct/2.5a 6.3v/2a 5v/2a	Upright or Flat
U or F125/285	"	125	285/285	6.3vct/2a 6.3v/2a 5v/2a	Upright or Flat
U or F125/325	"	125	325/325	" " "	Upright or Flat
U or F125/385	"	125	385/385	6.3vct/2a 6.3v/5a 5v/3a	Upright or Flat
U or F150/285	"	150	285/285	" " "	Upright or Flat
U or F150/325	"	150	325/325	" " "	Upright or Flat
U or F150/385	"	150	385/385	" " "	Upright or Flat
U175/425	"	175	425/425	6.3vct/3a 6.3/2a 5/3a	Upright
U200/385	"	200	385/385	6.3vct/3a 6.3/3a 5/3a	Upright
U250/385	"	250	385/385	6.3vct/4a 6.3/3a 5/3a	Upright
*T80/265	"	80	265/265	6.3vct/2a 5v/2a	Upright

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E.30/80	30	80	380
F.15/100	15	100	300
F.15/125	15	125	250
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F.12/200	12	200	125
F.12/250	12	250	133

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AERIAL BATTLES IN CLASSROOM

Tactics in the field of battle are said to have been developed from the game of chess, which helped the kings of small countries and commanders in the field to practise ways of manoeuvre and evasion without loss of life or paying very heavily for their mistakes.

MODERN warfare, so dependent on air strength, must rely largely on radar, but the commanders of today have been handicapped in their tactical exercises because of the high cost of large-scale air manoeuvres, which, in any case, cannot be conducted on a completely realistic scale.

A solution to the problem is offered by a new instrument called a radar simulator—the prototype was shown recently in London—which enables tacticians and students to conduct a complete aerial battle by radar without taking a single aircraft off the ground.

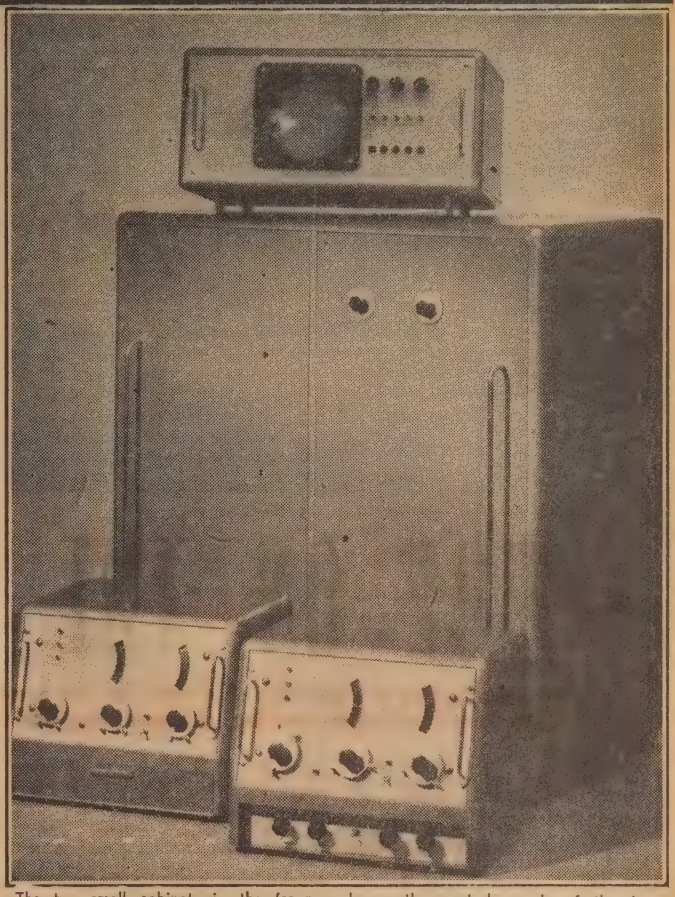
Designed by a British electronic engineer, Mr. Christopher E. G. Bailey, to train radar operators and controllers, the apparatus consists of a central computer unit, which is a mass of rotating machinery and valves, and a presentation unit at which pupil and instructor can sit. Grouped elsewhere may be as many as 20 control units, each of which represents a given aircraft or group of aircraft. In a typical tactical exercise, these would be divided up among friendly forces and "enemy" forces; the instructor would set a problem by arranging for his "enemy" forces to fly on set courses and the pupil would have to work out means of counter-attack, from which he would learn, for example, the penalty of sending up too many of his ground forces, and too soon, in the wrong direction.

All the controls are completely realistic. The aircraft cannot turn, fly, climb or dive faster than their real counterparts, while the instrument is fitted with two kinds of jammers which simulate the counter-measures likely to be taken by incoming hostile aircraft.

Besides the military applications, the radar simulator will be of great value to civil aviation in training zone controllers—the men who have control by voice of the aircraft in the zone aiming to come in to an airport or fly across the airport's traffic lane.

Two important features of the apparatus are that it can be expanded to deal with future developments, such as guided missiles or new forms of counter-measures, and that in the training school the examiner can simulate the same conditions for each candidate—which, of course, is not possible when using actual aircraft.

The equipment has been developed in association with the Solartron Electronic Group Ltd., of Thames Ditton, Surrey, England.



The two small cabinets in the foreground are the control panels of the two "aircraft". Up to two dozen of these may be connected to the computor in the background, thus making up a complete tactical exercise. Each aircraft unit acts completely independently, flies its own track, and does exactly what the pilot orders it to do within the pre-set limitations of speed and turn dictated by the specifications for the particular type of aircraft being "flown".

WILL FRESH AIR BECOME OBSOLETE

(Continued from Page 13)

round unit costs 700 to 1100 dollars more than a good, forced-warm-air heating system, but part of the expense can be saved by cheaper building costs—windows can be sealed and walls can be solid.

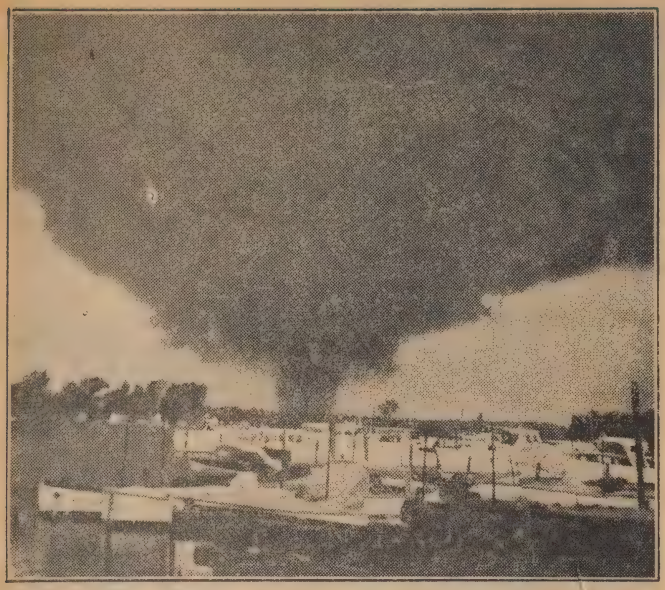
Visionaries see the rapidly approaching day when fresh air is obsolete, all America is totally air-conditioned and weather is merely an annoying memory.

Maybe that fresh air is just an old gas blanket full of debris, as they say, and weather is dispensable. But some people can't afford a complete year-round air-conditioning system all at once.

For them, an "add-on" cooling system which can be later attached to a furnace is the thing. Another economical method is to instal an independent central cooling outfit as a supplement to the heating system already in the home. The "add-on" conditioner is kind to the budget, permits even less prosperous citizens to join the crusade against weather.

If a workman shows up at your place with a batch of air-conditioning paraphernalia don't let him scare you. His talk of "wet systems", with their "refrigeration cycles, series loop piping and remote sources" sounds confusing — but it's really simple.

Hot or cold liquids are piped from a central unit to the various rooms of the house. To make any single room warmer or cooler, just turn a knob. And that's that!



Nature's most feared destroyer—the whirling tornado with its ominous, funnel spout sweeping across country with almost irresistible force. It is a form of localised cyclone and even more deadly than bigger ones in the area it strikes.

NATURE ON THE RAMPAGE

The recent introduction of radar into Australia for the purpose of plotting the course of destructive cyclones has added another milestone along the road of Australian meteorology.

by Calvin Walters

YEAR after year the coasts of Australia are periodically lashed by severe winds and rain which cause tremendous economic loss to the area which comes under their influence.

The most severe of these storms or cyclones which occur on the eastern coast of the continent usually travel from tropical regions over the South Pacific Ocean.

They gather considerable energy, and the severe south-east gales, rough seas and torrential rains are felt around the seaboard.

The course of these disturbances usually brings them from the north-east toward Mackay in Queensland. They then move toward the south and out again to sea thus following a parabolic curve.

FAVORED TIME

Very often the disturbance is felt well down into New South Wales, causing severe flooding of the northern rivers in that State.

While these storms may strike at any time of the year they occur most often during the months between September and May.

Cyclones are comparatively slow-moving disturbances. By this is meant that, while the winds within the disturbance may be very violent, the system itself may hover about an area for a week.

During that period the only evidence that it is there may be merely a showing of low pressure on the barometer. Then almost without warning the disturbance may intensify with great violence with a roar of wind and torrential rain.

When we speak of cyclones we refer meteorologically to systems of low atmospheric pressure.

There are two classes of cyclones, namely, the tropical and extra-tropical. The latter are far more numerous and may be seen depicted on any weather map in the newspapers as a succession of "lows" which pass over continents and oceans in endless succession from west to east. They are invariably accompanied by systems of high pressures sandwiched between two "lows".

These systems take about five days to cross Australia from west to east, and are accompanied by the usual changes of weather which we experience from day to day.

This five-day cycle is often manifest in a succession of wet weekends, which are brought about by a rainy "low" arriving at any given place on a Friday. With about two days of wet weather the next "high" arrives on Sunday night bringing fine weather to start work on Monday after a miserable weekend. The next "low" in the cycle then arrives again five days later on the next Friday and so it goes on until perhaps the system slows down a little and we may catch up a day or two until the rainy "low" arrives on a Monday and we can be miserable in the boss' time and still get paid for it.

Tropical cyclones, however, are much more rare than the extra-tropical variety, have no "high" or anti-cyclone as a travelling companion, are smaller in diameter and attain much greater force.

OCEAN SOURCE

Tropical cyclones are generated near the equator, but not directly over it. Neither do they form over continents. Their genesis is over the oceans, but they may occasionally invade part of the coastal area, but not to a great extent inland. Any effects which are felt inland is due to the outer fringes of the tropical cyclone, not the centre.

In tropical areas north of the equator the winds blow continuously from the north-east. South of the equator they blow from the south-east. These are called the trade winds. Between the two wind systems is a belt of calm called the "doldrums". This gave rise to the saying "in the doldrums", meaning, of course, that the thing or person or firm is not making any progress. It is stationary like the old sailing ships which entered the equatorial calm or doldrums and remained there for days or weeks waiting for a small blow to get across into the trade wind area.

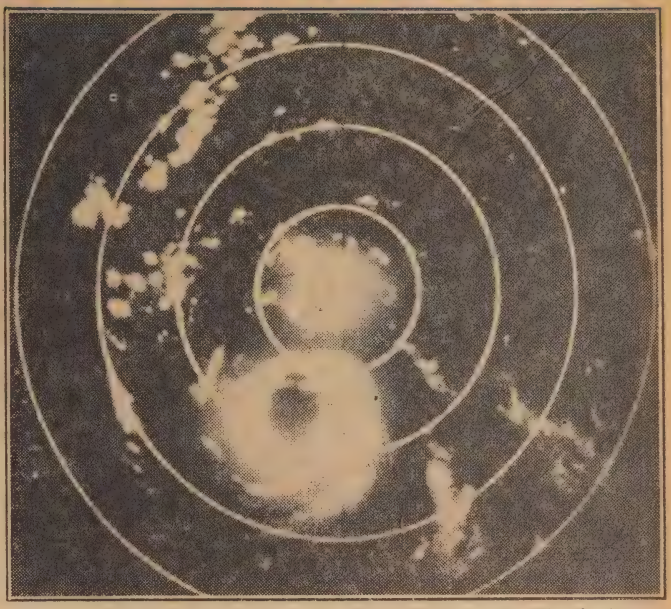
IN THE DOLDRUMS

It appears that it is in the doldrums that tropical cyclones develop.

During the year as the seasons change the belts of trade winds swing farther north or south of the equator according to the season.

Likewise, the belt of calm doldrums swings north and south with the advance or retreat of the trade winds. But when the doldrums

RADAR SCREEN SHOWS CYCLONE



The radar screen of an aircraft showing the entire twisting pattern of a hurricane. The area of comparative calm in the centre is clearly visible. The word "hurricane" means "killer wind".

are within an area of six degrees of the equator, cyclones are rarely formed, because the effect of the earth's rotation in deflection of the winds is slight in that region. Which brings us to another matter connected with cyclones.

When anything moves on the surface of the earth it tends to be deflected to one side because of the effect of rotation of the earth.

Thus if you were walking along a line from west to east some distance north of the equator, you would tend to swing up toward the North Pole. You would tend to move in an anti-clockwise direction. On the other hand if you were south of the equator moving parallel to the equator west to east, you would tend to swing down toward the South Pole and thus move in a clockwise direction.

So it is with the winds in cyclones. These move in an anti-clockwise direction in the northern hemisphere and a clockwise direction in the southern hemisphere.

Now, while we have a fairly good idea of where cyclones develop, scientists are more or less still at loggerheads as to how they develop.

CONVENTION PRODUCT

One school of thought says that they are caused by convection. A large mass of air becomes heated and moist compared with its environment and a huge upward motion results. This air has to be replaced, and it is replaced by cooler air, which flows in from all sides. Where convection is active, the atmospheric pressure over it is low. The rotation of the earth deflects the inflowing air stream and so we have a cyclone. The rotation of the earth and the centrifugal force generated by the whirling wind act as a brake on the movement of air toward the centre and the pressure there continues to fall. This business continues until the winds reach very high velocities.

There is a catch in this theory, though. Where does the air go to which is carried up and up? It has to get out somewhere otherwise the circulation of air within the cyclone would come to a stop.

Well, you see nobody knows. But the "countercurrent" fellows think they have a better idea, and it's nothing to do with "counter-lunch" either with or without currents—or raisins for that matter.

They say that a sudden invasion of cold air of polar origin into warm, rarefied air of the equatorial current MUST produce violent storms. Now that's easy, isn't it? We should be with this all the way, but let us go a little further.

CREATION OF FRONT

They say that the surface of separation between two air masses with different temperatures and different movements is called a "front". They say that "waves develop along this front, but the fronts tend to disappear as the cyclones grow, but continue at some upper level." That spoils it. At SOME upper level. Where?

All this means, of course, is that strong winds get together and whirl around in a low pressure system—anti-clockwise in the northern hemisphere and clockwise in the southern hemisphere. There is a lot of rain.

There is no doubt that temperature has everything to do with it whichever side you support. It's the fronts and currents that make the same pudding in a different way.

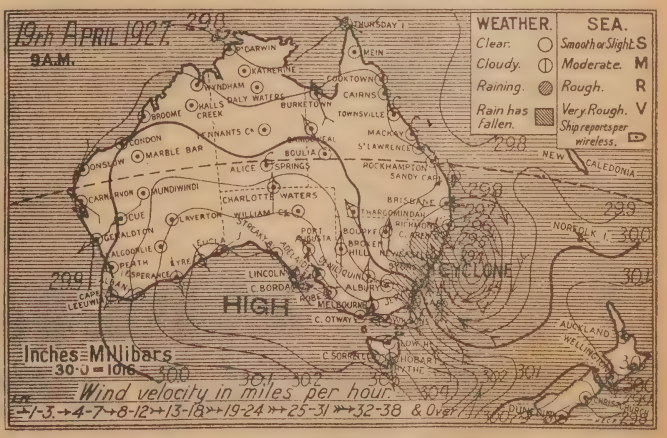
In a cyclone the winds blow inwards toward the centre while in a high-pressure system the winds blow outwards from the centre.

In a "low" the centre is the area of lowest atmospheric pressure. In a "high" the centre is the area of HIGHEST atmospheric pressure.

Because of the great dangers to life and property which are attendant to a severe cyclone or hurricane (a hurricane is a large edition of our tropical cyclone) there has always been great need for reliable advance information as to the possibility of a cyclone arising and the course which it may take.

Particularly is this important to shipping for there is no worse experience than to be in a ship in the centre of a fierce cyclone.

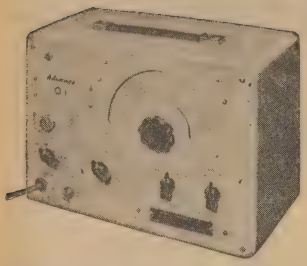
Land stations from which reports are radioed to shipping have been the most valuable safety measure up to the present time.



This old weather map of Australia shows a very well developed cyclone some distance out to sea off Sydney.

SIGNAL GENERATORS

by Advance



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A TORNADO PLAYS A FAVORITE

There are also weather stations situated on various islands throughout the danger area which radio reports to the mainland whenever the occasion demands. Such a station is situated off the coast of Queensland on Willis Island for the express purpose of keeping an eye on the cyclone which develops in that area, mentioned earlier in this article.

Generally speaking these cyclones arrive at night. Advance information is therefore all the more important, for it is most disconcerting to have to get up in the rain in your pyjamas in the middle of the night to tie the roof down if you are quick enough or put it back if you are too late.

Sometimes local conditions may give an indication of the approach of a cyclone some days in advance if the signs are interpreted correctly.

Because of the tremendous pressures built up on the surface of the sea by the force of the winds, "storm waves" are produced. These waves are propagated with a velocity much greater than the rate of advance of the cyclone which may move toward the coast at a speed no greater than 20 miles an hour. But the storm wave, moving faster in advance of the storm, may reach the coast days ahead of it.

These waves or ground swell are detected by a characteristic and unusual break or crack of the waves, which increases as the storm gets closer. These waves can herald a storm which may be 1000 miles away from the observer.

SURE INDICATION

On the eastern coast of Australia a steadily falling barometer with rising southerly or south-easterly winds is an almost sure indication that a cyclone is on its way.

Daily observations of the upper air have become more frequent in latter years. At first small pilot balloons were sent up. These were observed and charts made of their movements through the successive levels of the atmosphere thus giving the speed and direction of air currents above the surface of the earth.

This method has not been very satisfactory because in a cyclone the low clouds obscured the balloons from sight after a short while and the observations were not very valuable.

In 1935 use was made of small meteorographs which were carried up by sounding balloons. An automatic record of atmospheric conditions was made as the balloons rose. The balloons continued to expand as they rose until they burst and the instrument fell to earth.

Although valuable information was derived by this method the main difficulty was that the instrument had to be found before the record was available, and so much time was lost that there was often not much point in the finder racing to the Weather Bureau with an instrument which told them that a cyclone was here. His time was better employed stacking his furniture up in the attic or piling sandbags against the front door.

Then astounding results were obtained by sending a balloon aloft, equipped with a radio transmitter which radioed signals to a recording device in the weather bureaus. These instruments are called radiosondes. Special signals are radioed dealing with atmospheric pressure, temperature, wind velocity, wind direction and so on.

By this means observers gained a pretty fair picture of the progress of a cyclone and provided immediate information in all kinds of weather.

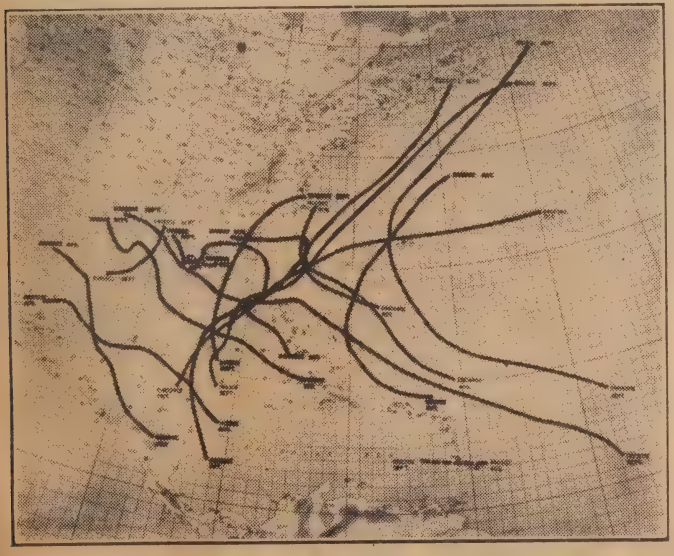
The latest method, and one which outdoes all others, is that now being used in Queensland to track down the aforementioned cyclone which causes so much damage in that part of the continent.

This is the use of radar.

The amount of rain which falls in a tropical cyclone is at times un-

(Continued on Page 118)

This picture shows what damage a tornado can do. Note how its sharp-edged force has missed the house at the extreme left, which has suffered little apart from a few displaced roof tiles.



Home of the hurricane is the Caribbean, and almost every year they threaten life and property in Florida. This map shows the paths taken by hurricanes during 1947-48. Note how many of them crossed over Florida.

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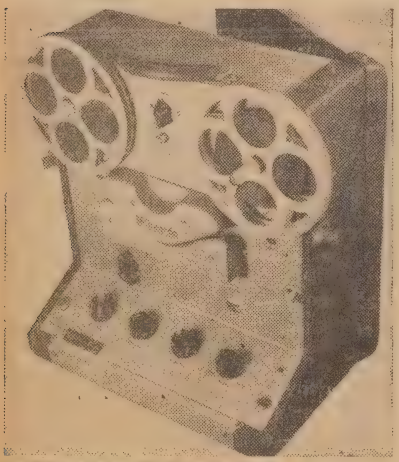

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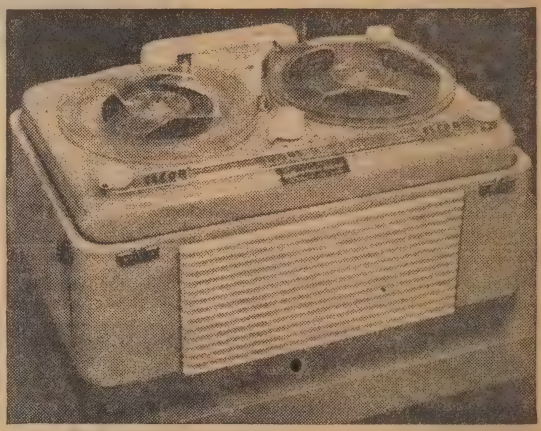

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Technical Review

SEEING-EYE "DOG" USES ELECTRONICS

Further details of electronic eyes for the blind, mentioned in these pages last year, are now to hand and it is interesting to note how experts from several American research institutions have combined their efforts to produce a reliable device which will enable blind people to travel alone with safety and assurance. Instruments produced so far operate on the well known radar principle using light rather than radio waves and reports on field tests by blind users are highly favorable.

IN 1943 the Signal Corps began the development of a travel aid to help blinded World War II veterans in their rehabilitation program. The scope of the problem soon included all blind people. Research went through several stages to a point where RCA was contracted by the Signal Corps to manufacture 25 prototypes of their Sensory Aid for testing and evaluation.

The Signal Corps Sensory Aid (see photo) is an electronic device intended to aid blind people in travel by warning the user of discontinuities in the terrain and obstacles in his path. The principle of operation is as follows: A beam of light interrupted 500 times per second is projected in a narrow beam from an optical system, strikes an object or the ground and is partially reflected into a second optical system.

PRINCIPLE OF OPERATION

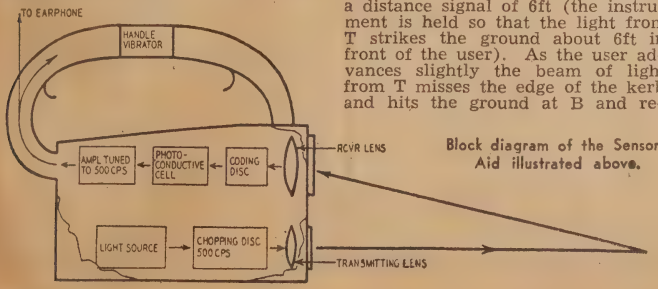
This second optical system focuses the reflected image on a perforated coding disc behind which is located a photo-electric cell. The output of the cell is fed through a four-stage amplifier to a vibrator in the handle of the instrument. The amplifier and vibrator are resonant at 500 cycles, the same frequency at which the light beam is "chopped." The coding disc interrupts the reflected light 4, 8, 16 or 32 times per second, depending on the distance to the object.

Thus, the repetition rate of the 500-cycle pulses in the handle informs the user as to the distance to an obstacle or discontinuity in the terrain; the position of the handle indicates the azimuth — that is, whether the obstacle is to the left, right or straight ahead.

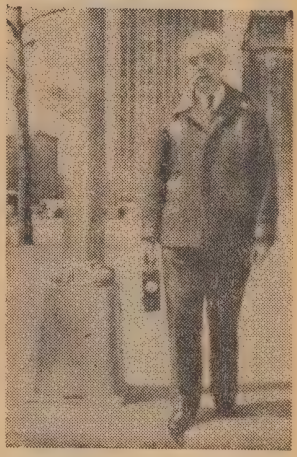
When looking for kerbs, the light

The Signal Corps Sensory Aid.

from transmitting lens T (see overleaf) strikes the ground at the edge of a down kerb at point A and is reflected to receiving lens R, giving a distance signal of 6ft (the instrument is held so that the light from T strikes the ground about 6ft in front of the user). As the user advances slightly the beam of light from T misses the edge of the kerb and hits the ground at B and reflects to R. This causes the distance signal to increase suddenly from 6ft (T to A) to approximately 7ft (T to B).



Block diagram of the Sensory Aid illustrated above.



The electronic travel aid is shown here being used by a blind subject as part of the test and development program.

This sudden change in range of 1ft is detected by a very subtle change in the vibrator signal in the handle of the instrument.

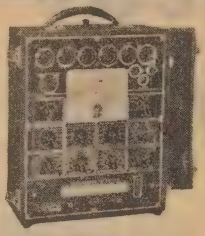
Representing a cross-section of the blind population, 67 subjects were tested: 9 used seeing-eye dogs as guides before trying this electronic travel aid, 16 used a cane, 40 a sighted person and 2 no guide. Of the cane users 8 were willing to change from cane to Sensory Aid; 3 of the 8 who preferred the cane said, "I prefer the feeling of firm contact with the ground which a cane affords."

THE RESULTS

Of those tested 37 had difficulty in detecting kerbs. This was chiefly due to the fact that the kerb signal was an extremely subtle and fleeting change in the distance signal which occurred when the beam of light passed over the edge of either an "up" or "down" kerb.

An "up" kerb appeared as a momentary slight decrease in distance; a "down" kerb as a momentary increase in distance. False kerb signals were frequently obtained because of the change in distance to the point where the light fell on the

UNIVERSITY service aids...



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Model MVA/2: This popular Multimeter is built to careful standards of accuracy and utilises 1 pc resistors throughout to ensure maximum efficiency. It covers AC-DC and output voltage ranges up to 1000 as well as D.C. current ranges up to 250 milliamperes. In addition there is a special 10 ampere D.C. range as well as four ranges of resistance up to 1 megohm.

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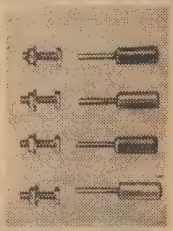
This useful instrument will find many applications where alternating current is to be measured. It is designed for use with Multimeters which have a 1 m A.A.C. range such as Model MVA/2. Used in conjunction with such a multimeter, it provides the following alternating current ranges which are selected by a switch on a clearly marked etched label: 0/2.5, 5, 10, 25, 50, 100, 250, 500 milliamperes. 0/1, 2.5, 5 and 10 amperes. Leads are supplied. Size is 6in x 4in x 3¼in.



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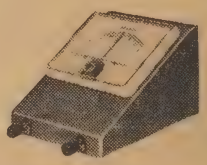
Model B10.

Illustrated here is the University Model F3 meter mounted in a sloping front bench stand and fitted with terminals. This type of meter and stand is widely used for instructional work and bench type testing in laboratories. It is ideal for experimental setups and the sloping face allows the meter to be quickly seen under all conditions. It follows a conventional standard pattern and is sturdily constructed and light in weight. Fabricated of steel and finished in grey brocade it is hard wearing. It is ready stamped and drilled to accommodate the F3 meter and is supplied with bakelite terminals with non-removable tops. It can be supplied with or without meter



METER STANDS

Model B20.

Illustrated herewith is the University Model W4 meter, mounted in a sloping front bench stand and fitted with terminals with non-removable tops. This stand is of steel finished in grey brocade and is ideally suited for testing laboratories, experimental setups, technical colleges, schools and the like. The stand is ready stamped and drilled to accommodate either the W4, U4 or R4 meter. Model B20 stand can be supplied with or without meter and can be used as either a 60 degree sloping front stand or 30 degree sloping front

A RECENT OBSTACLE DETECTOR

ground (a result of instrument jiggling).

It was evident that there is a need for a kerb detector not affected by the irregular movements of the hand as the user walks. Eight had no particular trouble, 12 had difficulty detecting obstacles. Six were unable to perform the necessary scanning motion with the wrist to "see" obstacles slightly to the right or left. Four found the change in reflectivity of different surfaces bothersome because the change in intensity was sometimes interpreted as a change in distance. Twenty said the weight of 4.5lb was excessive. All subjects found the continual signal presentation tiring.

To discover what would happen if the instrument were used over a prolonged period, 5 subjects used it in their everyday life over a period of six months to a year. The novelty did not wear off and they were most anxious to have the instrument repaired when a failure occurred.

DIFFERENT REQUIREMENTS

The results of this program indicate that the two most important improvements required for future development are: Separate kerb and obstacle detectors, which remain quiescent until there is information to be transmitted; separate kerb and obstacle signals (stimuli) sufficiently distinct so that the user has no difficulty in recognising them.

The testing program has indicated conclusively that in the final production of a satisfactory travel aid, models of varying complexity should be provided. Some blind people are not capable of assimilating information at as high a rate as others and are confused by having more information presented than they are capable of interpreting.

A three-year development program got under way on February 1, 1953, with the signing of a contract between the Veterans Administration and Haverford College at Haverford, Pa.

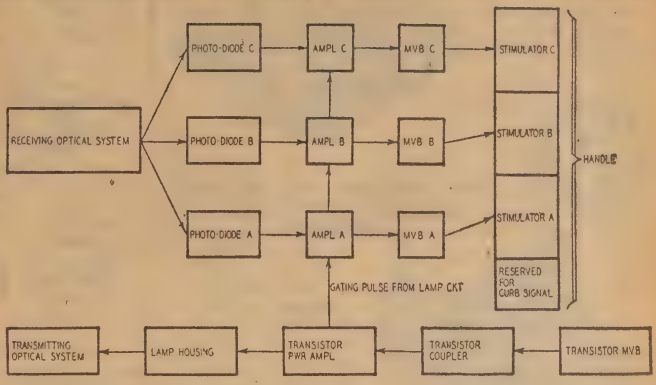
It was desired to construct a travel aid that did not have any moving parts and which required much less battery power. To make a simple, probe type obstacle detector would not be too difficult; a satisfactory kerb finder much more so.

Since the contract got under way, considerable progress has been made. The third experimental obstacle detector is nearing completion. Instead of the relatively cumbersome motor, chopper and incandescent lamp which consume about 900 mw, a pulsed gas-discharge lamp is used having a power consumption of about 50 mw.

CLEVER CIRCUITRY

A xenon lamp is operated by a transistorised power supply consisting of a multivibrator, a coupling transistor and a power amplifier. This circuit produces a pulse of 200-microsec duration at a repetition rate of 20 pulses per second with a peak value of about 40 volts.

This pulse is superimposed on 80 volts of battery potential to provide a peak of 120 volts, the potential required to "fire" the lamp. After the lamp fires, the voltage drops to about 100, where it stays for 200 microseconds. When the transistor power supply "turns off" at the end of the pulse, the voltage drops to 80

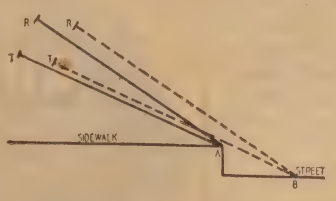


Block diagram of a recently developed type of obstacle detector.

and the lamp extinguishes. Thus, the transistor power supply has to supply only about one-third of the voltage required to "fire" the lamp.

The light reflected from an obstacle is focused on one of three photosensitive germanium diodes, depending on the distance to the obstacle. If the obstacle is closer than four feet, the reflected light falls on diode A; between four and seven feet, on diode B and between seven and 10 feet on diode C. The signal from each of these diodes passes through separate transistorised transformer-coupled amplifiers. The output of each of these amplifiers triggers a transistor multivibrator, the output of which drives the stimulator in the handle of the instrument.

Thus, if diode A is illuminated, amplifier A triggers multivibrator



This diagram shows how the Sensory Aid is used to locate kerbs.

A, which in turn operates stimulator A. Stimulator A in turn communicates with the index finger of the hand. Channel B stimulates the middle finger and channel C the fourth finger. Such a three-channel parallel system should be a distinct improvement over a one-channel system because, even if one channel fails for some reason, the other two can still operate. The signal amplifier does not have to supply power to the stimulator, but simply serves as a switch to turn on the multivibrator.

Since this amplifier is gated by the lamp pulse, the vibrator is silent except when there is information to be given to the user. This gating action affords an additional advantage because the amplifier is "turned off" so that no transient signals can get through except during the 200-microsec period that the lamp is on.

The total battery drain for the complete system with one stimulator operating is about 165 mw broken down as follows: Lamp, 80 ma at 100 volts, consumes eight watts peak. With a duty cycle of 250 this corresponds to an average power of 32 mw. The lamp drive circuit is approximately 70 pc efficient so that the total power required to drive the lamp is about 50 mw. Each channel consumes approximately 7 mw and each stimulator plus multivibrator 75 mw. Of course, if all three stimulators are operating simultaneously, which might occur occasionally, the total power drain would be approximately 300 mw. The stimulus for warning kerbs and steps would come from a fourth channel activating the little finger.

POWER ECONOMY

In the Signal Corps device the lamp was on all the time. This is a waste of power since it is necessary to take a "look" only occasionally and for a brief instant. In the above model a "look" is taken for 200 usec only 20 times per second.

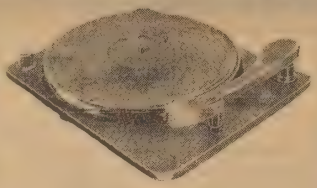
It may be possible to use even shorter duration using surface-barrier transistors recently developed by Philco, producer of a special photosensitive surface-barrier diode for this project.

At the present, results are promising. The noise level of this transistor is comparable to and perhaps better than previous types and the frequency response characteristic appears satisfactory for pulse durations as short as 50 usec. A channel using pulse durations as short as this would require surface-barrier transistor amplifiers.

Thus, the obstacle detector seems pretty well established. However, the kerb-locating problem is far from settled. It is planned to project a portion of the otherwise-wasted light through an optical system which would focus it on the ground about

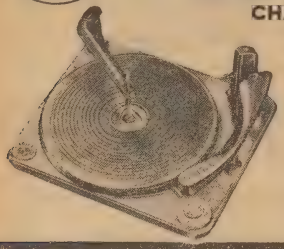
(Continued on Page 37)

MODEL GU4
Three speeds (33⅓, 45 and 78). Available with crystal or magnetic cartridge. Smart appearance. Obtainable from your usual stockists.



BSR

THE WORLD'S BEST-SELLING RECORD PLAYERS AND CHANGERS

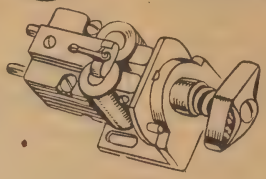


"MONARCH" Record Changer

Plays 7", 10", 12" discs at 33⅓, 45 or 78 r.p.m. The only changer to play 10 records intermixed.

Goldring

VARIABLE RELUCTANCE CARTRIDGE No. 500



Now recognised as the world's best cartridge. American "Consumer Reports" rates Goldring Variable Reluctance No. 500 FIRST among all high-fidelity cartridges.

Goldring

PICKUPS

Goldring Pickups are available with Cartridge No. 500, Magna Cartridge No. 200 and a variety of crystal cartridges. Please ask for leaflets.

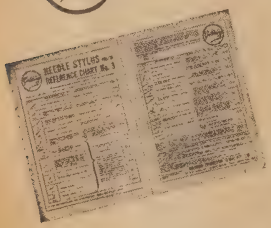
GOLDRING

ENGINEERING (A'sia) Pty. Ltd.
57 H.E. Area, St. Marys, N.S.W.

wish all their friends a very happy Christmas and a prosperous New Year

Goldring

SAPPHIRE AND DIAMOND STYLI



For full details concerning all Goldring styli, refer to Goldring Stylus Fitting Instruction Chart. Supplies of charts are available free.

Goldring

"PLAY GRAM"

This amazing three-speed record player and amplifier has superb tonal quality and plenty of volume, too! Features the world-famous B.S.R. GU4 three-speed record player.

GRUNDIG TAPE RECORDER

THE WORLD'S FINEST

The world-famous Grundig Tape Recorder, Models TK12 and TK20, have a host of **exclusive** features designed for convenience, value, quality and absolute simplicity of operation.

ELECTRONIC WEIGHING ON THE PRODUCTION LINE

Yet another instance of electronics finding its way into big industry is a new weighing machine which automatically sorts parts into as many as 60 weight categories with an accuracy of better than 1/10 pc at rates up to 3000 per hour.

AUTOMATIC production in industry has brought increasing need for high-speed weighing and the electrodynamic scale provides a means of giving the information rapidly and accurately.

Two methods of measuring weight are in common use. In the first, as in a beam balance or pendulum scale, a known weight is balanced against the unknown with a manually or automatically adjusted lever arm giving the ratio of the two weights. In the other method, as in a spring scale, the weight is determined by measuring the displacement of a calibrated spring supporting the unknown weight.

BASIC ACCURACY

The balance-type scale is inherently more accurate but is slower than the spring scale because a mass, in addition to the unknown weight, must be added to the system. The accuracy of the spring scale is limited by the basic characteristics of springs but spring materials are now available that greatly reduce errors due to hysteresis, creep, zero drift and change of spring modulus with temperature. Errors are further reduced by using the dynamic weighing principle and by the repitition of a uniform loading sequence.

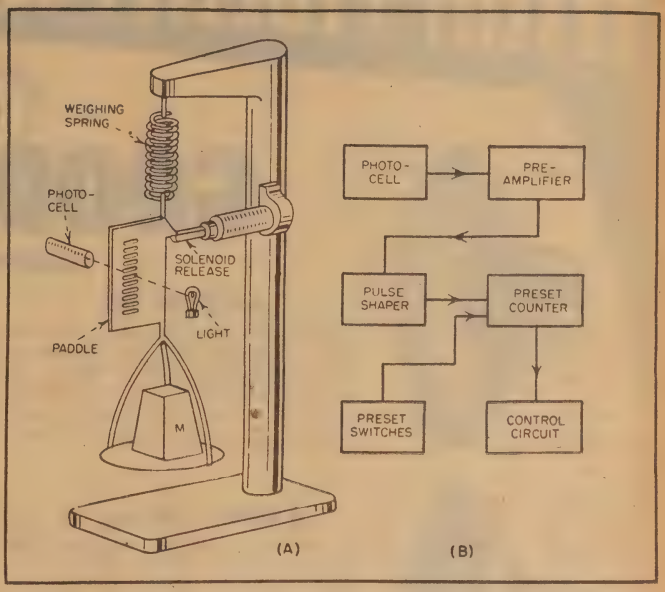
The figure illustrates the operation of the dynamic weighing machine. The weight platform is locked during the time the weight is being placed on it or removed. When the weight is in position, the lock is released so the platform falls and the system goes through one cycle of free oscillation. The maximum excursion of the system is twice the distance from the locked platform position to the equilibrium position that would be reached by an equivalent damped system. The maximum excursion is linearly proportional to the weight and therefore can be used as a measure of the weight.

USE OF ELECTRONICS

The requirement for measuring motion suggests the use of electronics and an electronic measuring method which is both accurate and flexible has been developed.

A lightweight arm or paddle is mechanically coupled to the platform so that it moves with the scale platform. Slots corresponding to equal increments of weight are cut in the paddle and as the paddle moves, these slots interrupt a light beam falling on a lead sulfide photocell. The output pulses from the photocell are fed to a counter where they are added and stored so that the weight can then be read directly from the counter or the counter used for control of other devices.

In industrial weighing, it is often necessary to classify articles into several weight categories or zones.



A skeleton diagram showing the principle of the electrodynamic weighing machine. (A) Slotted plate interrupts light to photocell providing pulses to counter through preamplifier and pulse shaper (B).

The electrodynamic scale can be adapted readily to this application by the use of a predetermined counter. The zones are set up by adjusting the predetermined count selector switches so the desired count will fill the counter and produce a read-out signal or zone indication. The counter circuits can also be arranged so the read-out signal resets the counter to a second zone. Any reasonable number of zones can be chosen in this manner.

ORDER OF ACCURACY

The accuracy and linearity of this type of weighing system can be held to better than 0.1 pc under most conditions. Since it is essentially a digital system, its accuracy is not dependent on the stability of the electronic equipment. The photocell amplifier is designed to have a large margin of gain so that ageing of the photocell or amplifier tubes will not result in faulty operation. A shaping circuit is employed between the photocell amplifier and the counter such that the correct pulse for positive counting will be fed to the counting stages even if the pulses from the photocell are distorted.

The automotive industry has been the first to use this weighing technique. In automobile engines, balance of component parts has been found to be of increasing importance. Connecting rods, for example, should be uniform in weight and should have centres of gravity located at the same point. One automobile manufacturer accomplishes this by weighing and sorting all connecting rod forgings, before any machining is done on them. Subsequent machining is then so adjusted that each connecting rod is machined to the same weight and has its centre of gravity located at the same point.

One scale was developed in co-operation with the US Army and one of its suppliers of 20-mm ammunition. A typical contract for this size ammunition might be for 2 to 3-million rounds, so that it is impossible to hand weigh each round without greatly increasing manufacturing cost. However, the electrodynamic scale allowed 100 pc inspection of these parts to an accuracy of a few grains (1 grain equal 1/7,000lb) and at the same time eliminated the need for an operator.

APPLICATIONS

Aircraft jet-engine impeller blades must have a constant moment of inertia with respect to the centre of rotation. It is necessary accurately to locate each blade on the scale and then measure its moment of inertia. The operator releases the scale by means of the foot switch and reads the zone number corresponding to a value of moment of inertia from the electronic counter located on top of the scale. An engine is then assembled with all blades from any one of 60 zones.

The basic scale unit is capable of check-weighing cartons and detecting off-weight units within the carton. It is also useful in checking total production weight for a period of time since its controls can be arranged to totalise the number of cartons in each of 20 or more weight zones passing over the scale, at rates up to 25 or 30 cartons per minute.

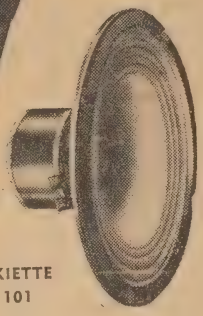
—*(Electronics)*.

HIGH FIDELITY EQUIPMENT FOR

A TRADITION OF EXCELLENCE
FIDELITY
EFFICIENCY

GOODMANS

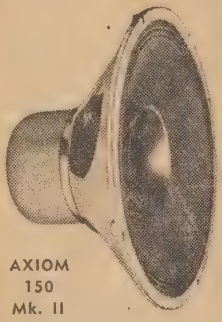
LOUDSPEAKERS



AXIETTE 101

AXIETTE 101

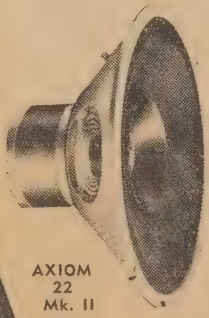
Single Cone 8in. Response 40-15,000 CPS. Resonance 65 CPS. Wattage 5. Flux 13,500 Gauss, dust proof.
Specially developed for maximum fidelity where space is restricted. A useful unit for full response, used singly or in multiples, also an excellent tweeter.



AXIOM 150 Mk. II

AXIOM 150 Mk. II

Twin Cone 12in. Response 30-15,000 CPS. Resonance 35 CPS. Wattage 15. Flux 14,000 Gauss, dust proof.
An improved model of the already famous Mark I. The tweeter has been modified to give flatter response, making it easy to apply, yet retaining hardness so necessary for high notes, giving presentation not obtainable from single cone speakers with similar response.



AXIOM 22 Mk. II

AXIOM 22 Mk. II

Twin Cone 12in. Response 30-15,000 CPS. Resonance 35 CPS. Wattage 20 dust proof.
The recognised leader in Hi-Fi circles. The huge 17,500 Gauss magnet gives improved transient response and presence that is easily recognisable.

AXIOM 80

Twin Cone 9¼in. Response 20-20,000 CPS. Resonance 20 CPS. Wattage 4/6. Flux 17,000 Gauss.
An entirely unique unit embodying a patented absolutely free edge cone with double cantilever suspension. A movement of such low mass that the cone may be moved by blowing on it. Exhibits remarkable transient response at all frequencies. Absence of bass resonance, plus the extended high frequency reponse gives a feeling of extreme naturalness.

AUDIOM 50 Mk. II

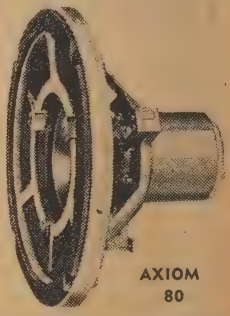
Single Cone 12in. Response 30-9000 CPS. Resonance 35 CPS. Wattage 10. Flux 11,500 Gauss.
The Junior member of the Goodmans' family. A first step in Hi-Fi — to improve any standard radiogram.

AUDIOM 60 Mk. II

Single Cone 12in. Response 30-10,000 CPS. Resonance 35 CPS. Wattage 15 Flux 14,000 Gauss.
This is an excellent full range unit making an ideal bass speaker when used with the Axiette and a cross over network. Copies are available.

AUDIOM 70 Mk. II

Single Cone 12in. Response 30-10,000 CPS. Resonance 35 CPS. Wattage 20. Flux 17,500 Gauss.
Power handling is a secondary consideration when compared to the improved transient response of this speaker. The response to 10,000 CPS makes this unit the "best" for those who would fail to understand the extended response of the twin cone series.



AXIOM 80

U.R.D. FOR HI-FI

TRUESOUND REPRODUCTION

The entirely new PLESSEY Multi-speed Record Changer (illustrated) is fitted with a HGP37 T/0 head. The universal tone arm will accommodate T/0 pick-ups such as Goldring Variable Reluctance, Ronette 284 Professional and Acos Ceramic heads. Modern in appearance and reliable in performance.

A comprehensive range of Motors, Players and Changers suitable for HI-FI equipment are available.

MOTORS

Connoisseur Variable Speed.
Fidelotone.
Garrard 301 Variable Speed.
General Acoustics Belt Drive.
Thorens E53N PA.

PLAYERS

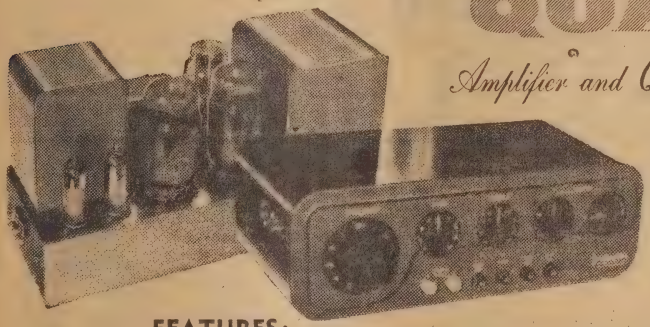
Collaro 2010 Transcription.
Collaro AC3/ 554.
Dual 280 Automatically Changes, 45 RPM.
Garrard T.
Thorens CB33N Manual GE Pickup.
Thorens CBA83N Automatic GE Pickup.

CHANGERS

PLESSEY Type 'D'
Garrard 80.
Garrard 90.
Garrard 101.
Dual 1003.
Thorens CD43N.
Thorens CD53N.

QUAD II

Amplifier and Quality Control Unit



FEATURES:

Effortless finger-tip control — full range fidelity 10 to 60,000 cps + or — ½ db—push-button record equalisation — perfect plug-in matching to any pickup — built in pre-amp — automatic circuit correction — independent filter and filter slope controls — 15 watts output throughout 20 to 20,000 cps — less than 0.1% total distortion.

The new Acoustical Quad II is truly an instrument designed for the home. Its beautiful styling is unparalleled in the high-fidelity industry. Its specifications are second to none and were deliberately obtained with up to 20 pc valve mismatch, to be certain that the Quad II will always exceed its published specifications.

It is the most distinguished audio achievement of recent years combining Highest Engineering Standards with a New Concept of Styling for the home.

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"ACOS" CRYSTAL MICROPHONES and MICROPHONE INSERTS

A Complete Range For Every Purpose

DESK or HAND MICROPHONE

MIC 36

Housed in attractive plastic case, this Microphone is ideal for home recording and public address, etc. Response unexcelled for its size and price. The performance is not affected by vibration, shock or low frequency wind noise. Omni- directional frequency response substantially flat from 30 to 7000 c.p.s. Recommended load resistance not less than 1 megohm dependent on low frequency response. Can be supplied complete with switch and floor stand adaptor as required at a small extra cost.

£6/18/6

HIGH QUALITY MICROPHONE

MIC 16

Designed to meet even the most exacting requirements, this Microphone incorporates the world famous floating crystal sound cell construction. Its special characteristics are that its fine performance is not affected by vibration or shock. The fidelity is not impaired by low frequency noise.

SPECIFICATION

Recommended load resistance—not less than 1 megohm.
Output level —65 db ref. 1 volt/dyne/cm².
Frequency response—substantially flat from 30 c.p.s. to 10,000 c.p.s.
Directivity—non-directional.
Size—2-1/8in spherical diameter.
Connector—Standard international 3-pin.

£24/19/6

GENERAL PURPOSE

MIC 35

The MIC 35, undoubtedly the best value ever offered, is ideal for amateur transmitters, public address, etc. Housed in an attractive die-cast case, it features a high sensitivity and substantially flat characteristics. Provided with a built-in shunt resistance of 2 megohms, it will, when connected to the grid of the input valve, give a substantially flat response from 50 to 5000 c.p.s.

£2/15/-

SPECIFICATION

Output level: —55 db ref. 1 volt/dyne/cm².
Cable—approx. 4ft. of co-axial supplied.
Weight—6ozs. unpacked, 7 ozs. packed.
Dimensions—microphone only 2¼in x 2¼in x ¾in.

TABLE or STAND MICROPHONE

This omni-directional Microphone is robust in construction, with a pleasing appearance. Vibration, shock or low frequency wind noise will not affect the performance. The low frequency cut-off is dependent on the load resistance. The cut-off is given by the quotation, F = 80 divided by R, where F = c.p.s., R = megohms. An adaptor (floor mounting) is available at low extra cost.

MIC 22

SPECIFICATION

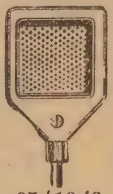
Output level = —50 db ref. 1 volt/dyne/cm².
Output impedance—equivalent to approximately 0.002 uF (0.8 megohm at 100 cycles).
Frequency response—substantially flat from 40 to 6000 c.p.s.
Recommended load resistance—not less than 1 megohm, dependent on low frequency response.

£9/18/6

LAPEL MICROPHONE

Designed to give freedom of movement, this Microphone is small and non-directional. Housed in a soft moulded rubber case, which gives protection against shock, it is provided with a pin at the rear of the case for pinning to the lapel.

MIC 28



Output level—approx. —55 db ref, 1 volt/dyne/cm².
Recommended load resistance—5 megohms.
Frequency response—level throughout the whole of the audible spectrum.
Capacity—0.0015 uF. at 1000 c.p.s.
Impedance—100,000 ohms at 1000 c.p.s.
Cord—6ft. shielded cable.
Size—1-9/16in wide x 2¼in long x 5/8in thick.

£5/19/6

HAND or DESK MICROPHONE

This Microphone has been designed for the high quality public address and home recording field. High sensitivity and flat characteristics are obtained by a specially designed acoustic filter. Housed in an attractive plastic case with an unexcelled response for its size and price. Unaffected by vibration, shock or low frequency wind noise. Omni-directional frequency response substantially flat from 30 to 7000 c.p.s.

MIC 33

£6/18/6

MICROPHONE INSERTS

(MIC 32 illustrated)

CRYSTAL MICROPHONE INSERTS

These inserts are available in varying sizes ranging from as small as 15/16in square to 1-13/16in round, with various thicknesses from 7/32in to 9/16in. Suitable for every purpose such as hearing aids, public address, tape recording, amateur broadcasting, etc., they have responses from 2250 c.p.s. to 3500 c.p.s. at 5 db to 30 db. Insert can be supplied with or without 10 meg. resistor as required.

MIC 19/4 and MIC 32, £2/15/6; all other, £1/19/6.

MICROPHONE INSERTS

(MIC 23 illustrated)

SOLE AUSTRALIAN AGENTS:

AMPLION (A'sia) PTY. LTD.

88 Parramatta Rd., Camperdown, Sydney, N.S.W.

Victorian Distributors. **DISTRIBUTORS CORPORATION 403 BOURKE ST., MELBOURNE.**

NEWS AND VIEWS OF THE MONTH

Power from the sun

IT seems only a matter of time before sunlight, the most universal source of power in the world, is harnessed to serve mankind.

The problem is a sticky one, but there is evidence of increasing scientific effort to solve it.

Methods of producing fresh water from salt water by sun action in Australia, Cyprus and Algeria were discussed at the World Symposium on Solar Energy held recently in Arizona.

Australian representative, Bruce Wilson, of the CSIRO, said experiments were under way in Australia to provide water for cattle by solar distillation of water from underground streams.

Solar stills, in glass and plastic, might be able to achieve clear water from the sub-surface borings for about 30/- a 100 gallons.

Delegates from Cyprus said exposure of glass-type still to solar rays had produced water for irrigation on a small scale.

Soviet plan

A SOVIET plan to heat, cool and irrigate a city of 20,000 people by a solar power was outlined at the same gathering by Professor V. A. Baum, of the Soviet Academy of Sciences.

The site Dr. Baum suggested for his project is near Ashkabad, in Southern Russia.

He plans to build a concentric ring of 23 railway lines revolving around a tower, topped by a steam engine.

On each railway car will be a flat reflector, 10ft x 18ft, turned always to face the sun.

The reflectors will focus the sunlight on the tower engine, producing steam power.

Dr. Baum estimates that his device would yield each hour: 10,000 watts of electric power, 13 tons of steam, 19 tons of ice and 44 cubic yards of fresh water.

Power in bottles

AND from London comes a fantastic story of a man who claims he can "bottle" sunlight, and use it later to heat his home and cook his food.

He is Leslie Gardiner, 40-year-old managing director of a Bristol experimental engineering firm.

The secret of his bottling process lies in 30 five-pound high-pressure bottles.

In these bottles is Substance X, a formula which has taken him eight years to discover.

"I can store sunlight in Substance X for as long as 18 months," Mr. Gardiner said.

"It will heat my house in winter and cook my meals.

"In fact, I used some the other day to make the office tea."

The bottled heat can be boosted in temperature to 600 deg. F. and can do anything coal or electricity does in a normal house, Mr. Gardiner says.

He claims his process costs only about a 10th of what existing heating systems cost, is non-atomic and safe.

Prof. Cecil Pavell, Bristol University's Nobel Prize-winning physicist, said, "We know how to store heat for a time, but for nothing like as long as this"

A member of Mr. Gardiner's firm, which supplies equipment for the Harwell atomic research station, said, "I would describe Mr. Gardiner as a genius."

World population

HOW many people are there in the world? About 2500-million according to figures supplied by an American Bureau.

In the 1930's the world's population grew at only 22-million a year.

The Bureau cited Pakistan as an example of the problems the population growth had caused.

Pakistan had increased food production by 20 pc since World War II.

But the increase in population was greater.

Today food available for each person in Pakistan was 10 pc less than 15 years ago.

Nearer home, the rapidly expanding population of the Eastern countries is causing concern. Japan, for instance, is topping the 90-million mark, and growing at the rate of hundreds every hour.

Weather radars

TWO radar stations, first of a network of cyclone warning posts on the Queensland coast, will be ready next January.

The first two stations are being built at Brisbane airport and at Townsville.

Estimated cost of each station is £35,000.

Brisbane Weather Bureau chief B. W. Newman said each station would have a range of about 150 miles.

They would be able to give between 15 and 24 hours warning of approaching cyclones.

POPULAR SCIENCE QUIZ

Q.: For what purposes are sounding balloons used?

A.: Sounding balloons are used in large quantities by military and civilian weather services to obtain meteorological data on the upper air. The balloons carry radiosondes up into the stratosphere so that weather conditions at heights of 9 to 18 miles above the earth may be measured and the data transmitted to a receiving station on the ground. At such altitudes the temperature may be as low as minus 70 deg. C. Also, ozone, ultra-violet and cosmic radiations are much more prevalent than on the surface of the earth. These conditions, as well as the decrease in pressure with altitude, all have a bearing on the height to which an aerological sounding balloon will rise before bursting.

Sounding balloons are usually made of a Neoprene film with an unstretched thickness of about 0.003in and a weight of 500 to 600 grams. They are inflated with hydrogen or helium to a specified lift and, when released, rise about 0.3 km/min.

Q.: What is the cost of a television camera? £5, £50, or £500?

A.: None of the three figures given is correct. According to the latest information available from England, a good studio type camera may cost from £2000 upward. It is an extremely complicated piece of machinery and one component alone, the camera tube, costs about £800. It is in this tube where the image formed by the camera lens is converted into electrical impulses.

Q.: What is meant by "canned" television shows?

A.: The word "canned" usually refers to television programs which have been recorded prior to transmission, by some means or other, as opposed to "live" programs, which are transmitted directly from the stage or studio.

At present, a "canned" program usually means a program recorded on film, and transmitted through a film-scanning device. However, quite good results have been obtained in America, even for color TV, with recording the electrical impulses from the TV camera directly on to tape. The process and equipment is similar in principle to tape recorders used for sound recording, with the exception of tape speed, which is much higher.

Q.: What provides the lift in a conventional aircraft, the propeller or the wing surfaces?

A.: Their functions cannot rightly be separated. The motor and propeller impart forward motion to the craft and, in moving through the air, the wings produce a lifting effect. They therefore divert some of the energy put out by the motor and prop. to lifting the aircraft. The action is closely analagous to what happens when a car climbs an incline, where the power of the engine is used to overcome frictional losses, propel the vehicle — and raise it. In the case of an aircraft, the interaction of the wing surfaces and the air provide the incline.

AWV

I heard the bells on Christmas Day,
Their old familiar carols play,
And wild and sweet
The words repeat,
Of peace on earth,
Goodwill to men.

Longfellow

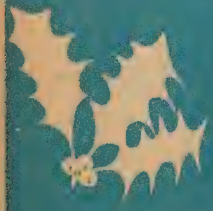
A Merry Christmas and

A Happy and Prosperous

New Year

from

AMALGAMATED WIRELESS VALVE COMPANY PTY. LTD.



Smog—a killer

BRITAIN is finally coming to grips with her smog problem.

Until recently, the poisonous mixture of smoke and fog was accepted as just another vagary of the weather.

But in December, 1952, the toll taken by a continuous four-day smog which descended upon London one weekend, was so heavy that the danger could no longer be ignored.

That December, some 4000 Londoners died from respiratory ailments aggravated by one of the worst smogs in history.

So experiments in the prevention and dispersal of smog were given top priority.

While the scientists tackle the technical aspects of the problem, the British Government has stepped in with a plan to ban industrial smoke and grit.

A Clean Air Bill is expected to become law by the end of the year.

Under this, industrialists will be compelled to fit filtering equipment in any new factories.

Experts estimate that the largest single source of smoke — 45 pc of the total — comes from domestic chimneys.

To combat this, the Clean Air Bill will provide financial assistance to home-owners or tenants to enable them to adapt or replace present heating apparatus to burn smokeless fuel.

Britain's nationalised railways, whose smoke belching locomotives are exempted from anti-smog legislation, have long been the target of public abuse.

But by 1957, nearly 800 diesel locomotives will be in use in Britain, and more than half of these will operate in "black areas" where the smog problem is worst.

London of course is not the only sufferer from smog.

Any modern city is liable, and because of their geographical position, cities such as Los Angeles are particularly vulnerable when the weather is right.

Future planning cannot ignore this menace to health and efficiency.

In the Antarctic

AUSTRALIA'S Antarctic expedition has successfully established its first inland depot 100 miles south of Mawson. According to the External Affairs Department's Antarctic Division.

The party has completed the 200-mile round journey in two "weasels" in eight days.

Their next task will be to establish a substantial base depot 170 miles inland.

From this base they will carry out extensive explorations of mountain ranges extending far to the south-east.

Wider Jap TV

TELEVISION will reach remote parts of Japan when new micro-wave services are completed.

Work on a micro-wave network which will cover most of Japan is now being carried out.

The network will be used to relay TV programs throughout the country.

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METALLISED PAPER PRINCIPLE
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ONLY Microcap

. . . is wound with the special patterned metallised paper. The metallised paper technique consists of lacquered paper tissue on which aluminium has been deposited by evaporation and condensation in vacuo. This results in the deposition of a very pure metal with a thickness controlled at approximately four-millionths of an inch.

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An insulation resistance exceeding 20,000 megohms for all values at working voltage of 20°C. is obtained on Microcap Type W99.

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M2

The switch clock in its finished cabinet. Painted in a color to suit the surroundings it looks attractive in almost any setting.

BUILDING A SWITCH CLOCK

Clock-controlled radios have become very popular in recent months, as indicated by the success of our "Kloxette". However, many readers did not wish to make a special receiver for use with a time switch but would have liked to use one with existing receivers. For these readers, here are the details of R, TV and H time switch.

by L. Varady

NOR did our readers' ideas stop at switching a radio set on and off automatically. Quite a few uses for a time switch within the household immediately suggest themselves, some quite outside the field of radio.

One particular reader, the owner of a tape recorder, suggested that a time switch could be used to control both a tape recorder and a radio to record a program in the owner's absence.

Any other appliance or combination of appliances could equally well be controlled by the time switch, but we will leave that to the imagination of the individual reader.

USEFUL ALARM CLOCK

Even when the time switch is not needed in any special capacity, it makes an attractive electric alarm clock, which can be useful anywhere in the house.

Our task is then to provide details of a simple unit which can be adapted to a variety of uses without being tied to any particular one.

Constructional difficulties for such a unit are virtually non-existent as practically everything required is included in the clock unit, which is now readily available.

Add some means of connecting the unit to the mains and the required appliances, put the whole lot into an attractive cabinet and it is ready to work.

The clock unit for the time switch is identical to the one used for the "Kloxette", and consists of a conventional electric clock, with provision for triggering two sets of contacts at a predetermined time. Provisions are made to set the contacts to the time required, and also a knob to control the external circuit manually.

One set of contacts is permanently connected to a buzzer alarm, whilst the other set is available for external connection.

The current rating of the contacts in this clock movement is 5 amps, which is enough for most likely applications. In terms of power, a total load of 1200 watts can be handled.

Most domestic appliances have — or should have — three pin plugs for connecting them to the mains, so that the unit should provide three pin sockets. The power cord should also be three core flex.

TOTALLY ENCLOSED

This is about as much as we need to know about the requirements. Before we go on to the detailed description of the construction, however, a word of warning: The unit not only operates on, but handles the full mains voltage. Every care should therefore be taken to see that all connections are made correctly.

Also for safety's sake a totally enclosed cabinet for the unit is essential.

As the modernistic cabinet proved to be extremely popular with our readers we decided to design the cabinet for the time switch along similar lines. The result looked very pleasing indeed.

Nevertheless, its construction is very simple, and anybody at all handy with a few woodworking tools should have no difficulty in building it.

The cabinet—with the exception of the rear panel, which is 3/16in ply — is made of 3/8 in plywood.

The front panel is cut out first (at this stage with sharp corners) and the cutout for the clock movement made. It is wise to leave this panel slighly larger than the final size, so that it can be trimmed into shape when the sides have been fitted and the glue dry.

To make the fitting of the sloping sides easier, these should also be cut slightly longer than required. The excess can be cut off later. However, the sides and the top and botom panels should be held in a G-clamp and the edges planed so as to ensure that all four pieces are the same width and have parallel sides.

With the two sides tacked temporarily into position on the front panel, the top and bottom panels are

bevelled at the ends and adjusted with some coarse sandpaper until they are a perfect fit between the sides.

Needless to say that the sides in position should be checked with a square to make sure that they are exactly perpendicular to the front panel.

If everything is right, the temporary tacks can be pulled out, the respective edges coated with glue and the panels tacked back into position permanently.

ALLOW TO SET

After this the case will have to be weighted and left for at least 24 hours to allow the glue to set properly.

When the glue has set, the excess plywood can be trimmed off and the cabinet given its final shape, the corners being planed and sandpapered to the required round. Half-inch radius for the corners is about right; more than this might tend to weaken the wood too much.

To give the cabinet a neat appearance, the removable rear panel is recessed flush with the edges. To hold it into place, three ¾in wide plywood strips are nailed along the rear edge of the bottom and the side panels. These should be spaced back by the thickness of the rear panel.

Two 1⅛in dia. holes are provided on this panel for any standard size flush socket.

The legs are made of some suitable piece of softwood, planed or sanded to shape and attached to the bottom of the cabinet with long panel pins, and perhaps a little glue.

SAFETY FIRST

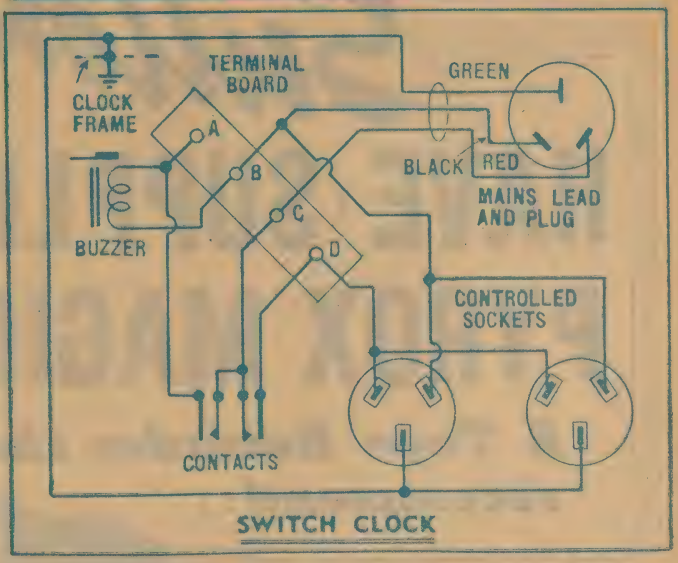
WHILST this time switch is perfectly safe if constructed according to the instructions, it must be pointed out that it only has a single pole switch. Owing to the lack of standardisation in the wiring of power points, this switch may be in the active or the neutral side of the mains.

If therefore any adjustment to the unit, or any appliance connected thereto, is required, it should be disconnected from the power point by removing the plug. Otherwise there is a danger that although inoperative, the appliance may still be "alive" internally.

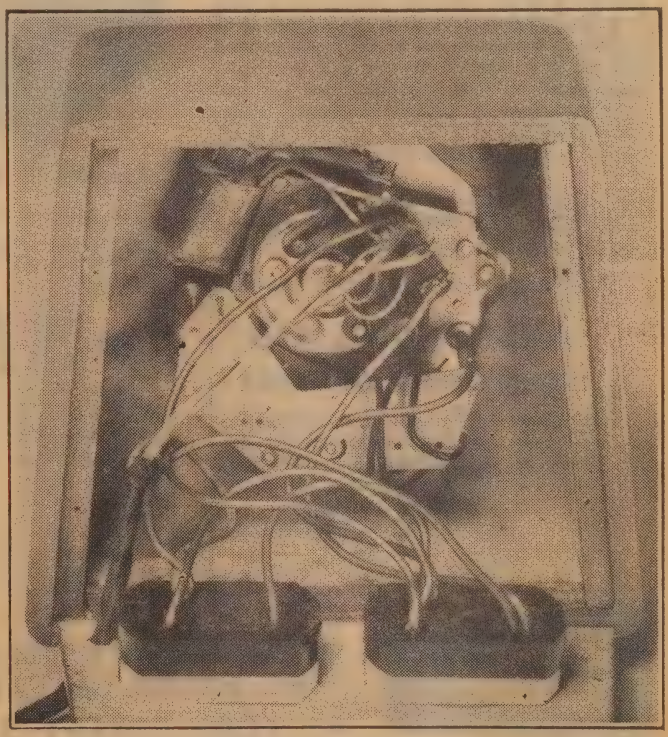
As the clock movement is supplied with the metal dial slightly larger than the perspex faceplate, it will be necessary to cut the corners of the dial. Although not normally recommended, the cutting is best done with a pair of tin snips. If the corners are removed with a file or hacksaw, the filings may get into the mechanism.

Having adjusted the dial to the correct size, the movement is then dropped through the cutout and the dial outline marked on the front panel. To allow the faceplate to lay flush on the panel, it will be necessary to recess the clock face into the wood. A recess 1-16in deep around the cutout will usually be sufficient.

CIRCUIT DIAGRAM OF THE UNIT



The circuit diagram is extremely simple, but care should be exercised with the connections, as they all carry the full mains voltage.

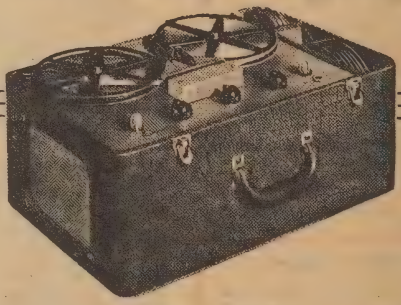


A rear view of the cabinet with the back removed, to show the connections and the position of the sockets. The extension shaft for adjusting the hands was removed for this picture.

Suttons

HAVE SUPPLIES OF PYROX MAGICTAPE

A Tape Recorder they highly recommend . .



This is a good, efficient, modern dual track machine which records on ordinary tapes up to 2 hours continuously, or on L.P. tapes up to 3 hours. It is easy to operate and is compact enough to be easily portable. See and hear the Magictape in Suttons soundproof studio. There you may try it out for yourself. It represents really good value at £135/8/4

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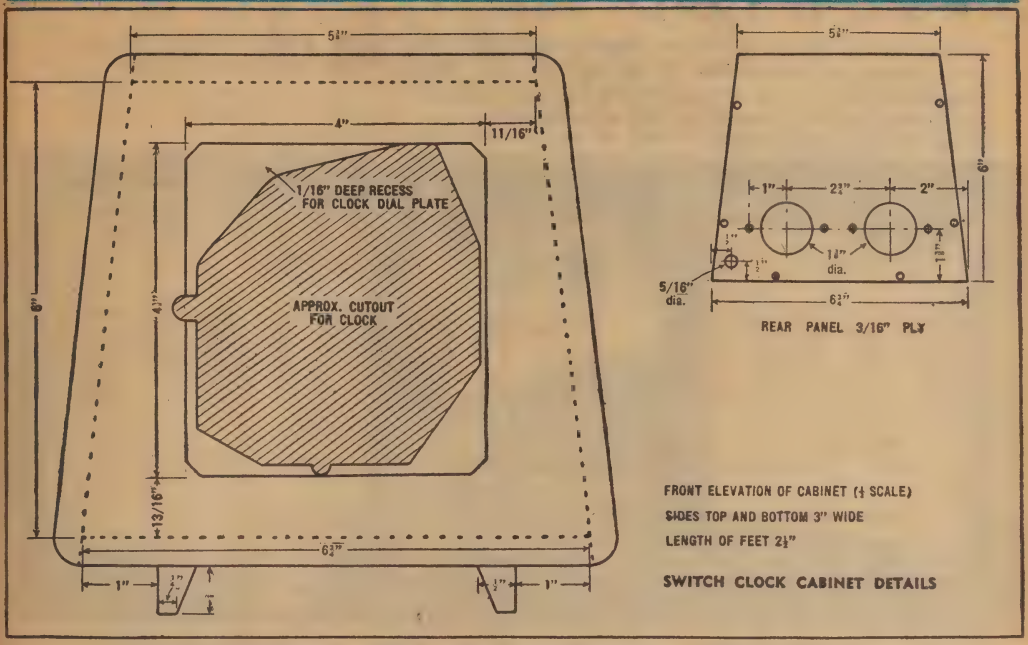
SOME DETAILS OF THE SWITCH CLOCK UNIT



This diagram shows the dimensions of the little cabinet we made to accommodate the clock.

The woodwork finished, the cabinet is ready for painting and, for a really nice job, the surface must be properly prepared. Surface discontinuities, nailholes and the like should be filled in with plastic wood, and the whole of the surface sanded first with coarse and then with fine sandpaper.

At least one coat of undercoat and two coats of paint are required for a good job.

COLOR SCHEME

Although the actual color selected will have to fit into the color scheme of your own home, we mention for the record that our cabinet was painted a bright red, which gave a very attractive combination with the old gold clock face.

When the paint has dried, the wiring and final assembly can be proceeded with. As pointed out, this should be done with utmost care, as mains voltages are involved throughout the unit.

The mounting of the clock movement is simple; it is held in position by the perspex face plate which is screwed to the front panel. Printed cardboard dials to fit under the face plate are available from this office at 1/- plus postage.

With the clock movement in position the terminal board at the rear will appear as indicated on the diagram. There are four terminals, which we coded on the diagram, as A, B, C, and D, A being uppermost. Terminal A is an internal connection and should not be used. B is the common terminal and carries one side of the mains, and one side of the controlled sockets. C is the other mains terminal, while D is the controlled terminal, which should be connected to the other side of the controlled sockets.

The green earth lead in the three-core mains flex is connected directly to the earth terminal on one of the sockets at the rear and looped from there to the other socket and the metal clock frame.

As mentioned before, the two "live" leads in the mains flex connect to the terminals B and C.

Most standard flush sockets have to be connected up before they can be fixed to the rear panel.

The fitting of a 3-pin plug to the mains flex completes the assembly and the unit can then be connected and checked for correct operation.

A few points here about the handling of the clock may not go amiss.

There are three controls provided on the clock, marked "Sleep", "Alarm-Off-Manual" and "Alarm". These are on the clock face proper, the adjustment of the hands being at the rear by means of an extension shaft.

PARTS LIST

1 Piece of ¼" plywood, approx. 16" x 16".
1 Piece of 3/16" plywood approx. 8" x 8".
1 Electric switch clock as used for "Kloxette".
2 3-pin flush sockets.
2ft twin plastic flex for sundry connections.
6ft 3-core cotton covered flex.

SUNDRIES

Glue, panel pins, woodscrews, small piece of wood for legs, paint.

The first control on the left-hand side of the face, "Sleep", provides for switching off the appliances connected to the time switch up to 60 minutes after the control has been set. The exact time required can be set on the dial next to this control.

Below the centre of the dial is what might be termed the function switch. In the extreme left position this switch brings the contact mechanism into action. In the centre position the contact mechanism is rendered inactive, while in the extreme right position the appliances controlled by the time switch are connected permanently in circuit.

ALARM SETTING

The knob on the right-hand side, marked "Alarm", is rotated to set the time of switching on on the small centre dial, whereby the small extension on the hour hand serves as an indicator. Pulling the knob out brings the built-in alarm into operation, about 10 minutes after the main contact has been switched on.

Any combination of control settings may be used, but it must be pointed out that the switching on and the switching off are not interdependent, the clock cannot be set to switch an appliance on at a certain time and then switch it off again.

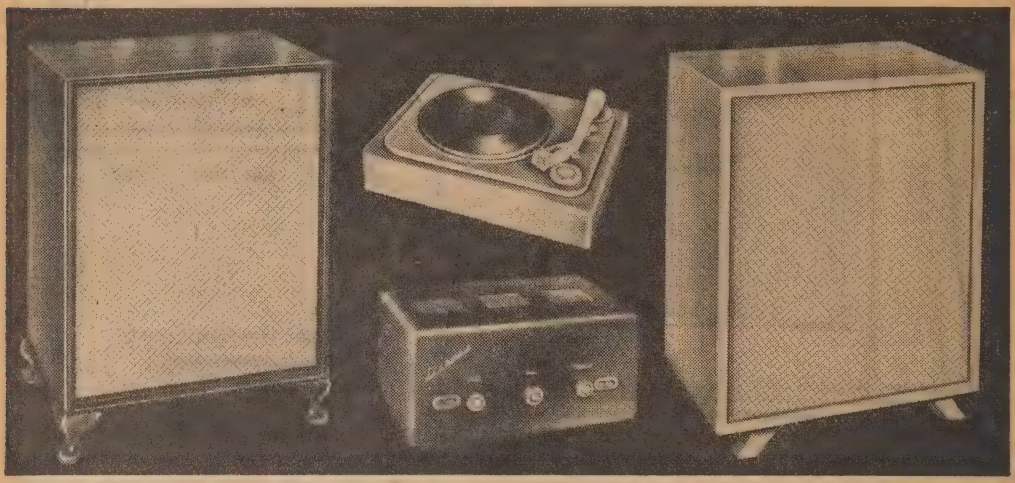
It is possible, however, for the time switch to switch off the appliance first, and then switch it on again after a certain time.

If the switching on is required more than once within any 12-hour period, the small centre dial must be rotated one revolution and the function switch brought to the "Off" position momentarily. This resets the mechanism for another operation.

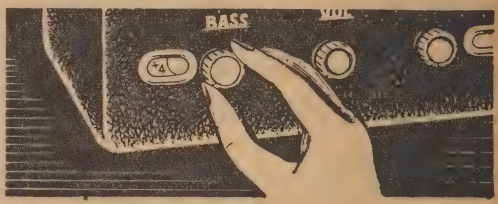
STEANES APOLOGISE!

The introduction of the Steane's HI-FIDELIGRAM created an unprecedented demand and caught us unprepared. Temporarily the HI-FIDELIGRAM is in limited supply.

Knowing how the HI-FIDELIGRAM fills the need of music lovers for something better than conventional record playing equipment, we have stepped up production considerably, and we are hopeful of filling all orders within the next few weeks.



Here are the reasons for the overwhelming success of Steane's HI-FIDELIGRAM



★ **VISI-AID INDICATORS:** Acclaimed as a master aid in selection of correct tonal colours. These indicators enable the record enthusiast to select the correct tonal balance; accurate calibration allows the music lover simple visual compensation for the varying record characteristics encountered.
A notation of the correct setting on the record cover allows the user to find the correct tonal balance whenever the record is replayed.

★ **LUXURY ENTERTAINMENT AT MODEST COST:** The cost of this HIGH FIDELITY equipment is reasonable indeed. The individual items, Sound Console, Amplifier or Record Player are also available separately.

★ **SOUND CONSOLE:** Quality from the two-speaker combination is excellent and the Crossover Filter most effective. There is a choice of Rosewood or Walnut Period Style or Blonde Contemporary Speaker Consoles.

★ **AMPLIFIER:** Completely encased therefore valves and other electrical components are not exposed. So handsome and neat that it need not be built into a cabinet, yet also lends itself for inclusion in or on modern built-in furniture.

★ **RECORD PLAYER:** Is a separate unit thus it may be located away from the Sound Console, preventing unwanted speaker vibrations reaching the pick-up head.

★ **NO HUNTING FOR COMPONENTS OR ADDITIONAL ATTACHMENTS:** The HI-FI-DELIGRAM is a complete HIGH FIDELITY Record Playback System, designed in the Research Laboratory at Steane's Sound Systems Pty. Ltd.

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367 Kent St., Sydney. BX6388

SEEING EYE DOG USES ELECTRONICS

(Continued from Page 23)

6ft in front of the user. A second receiving lens mounted at the top of the instrument would be focused on this spot.

The image of the spot would fall on a photosensitive surface-barrier transistor, the output of which would be treated in a manner similar to that in channels A, B and C. The output of the kerb channel would be applied to a multivibrator, with the output operating the fourth stimulator in the handle. This channel would work in reverse to the other three channels in that, so long as a signal was received, the multivibrator would not operate.

THE KERB

When a kerb came into the region where the spot of light struck the ground, the signal would disappear because no light would be reflected into the kerb receiving system. This would allow the multivibrator to operate the stimulator, not an ideal solution for three reasons: It requires that the instrument be held reasonably steady, which may not be easy to do in normal walking; changes in reflectivity of the surface of the ground may cause false signals (one particularly bad change in reflectivity is that produced by a mud puddle); the system will not detect "up" kerbs.

The stimulators located in the handle of the instrument (see photo) are somewhat unique. The handle is shaped to fit a wide range of hand sizes. The four fingers fit into small finger grooves in the bottom of the handle. The fingers are separated by a thin partition. Inside the handle are four small solenoid-operated plungers.

When the armature moves, it pushes a small round probe through a hole in the bottom of the handle. This probe pokes against the skin of the finger between the first and second joints.

BALANCED WEIGHT

The region between the first and second joints was chosen because the weight of the instrument comes naturally on this area so that it is a relatively fixed position between the finger area and handle. It was found that, if the user became tense and began to squeeze the handle, the operation of the probing stimulator was not seriously affected.

The obstacle problem will not be completely solved by any electronic device under consideration at this time. A blind person would be warned of an impending danger by the obstacle detector, 8 or 10ft in advance. It would enable him to make measures to "skirt around" the obstacle, thus avoiding embarrassment and potential injury. One of the problems encountered in testing the Signal Corps Sensory Aid was the tendency for the blind to stop to analyse the obstacle in an effort to determine its nature. He was constantly reminded, "Don't identify it, miss it."

—*(Radio-Electronics).*

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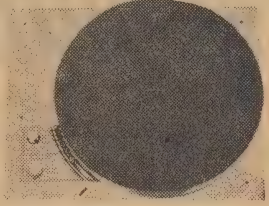

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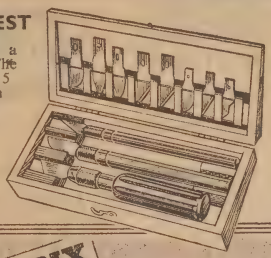

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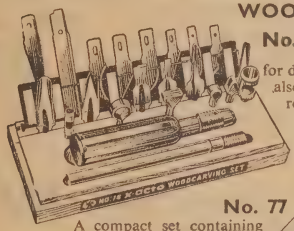

No. 78 A really fine set with both the No. 1 and No. 5 knives for delicate or heavy work. The set also contains the gouges, punches, routers and a good choice of blades all fitted into a stout platform block.

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A compact set containing the heavy duty No. 5 knife, 6 gouges and a selection of blades. Mounted for easy access on a platform block.

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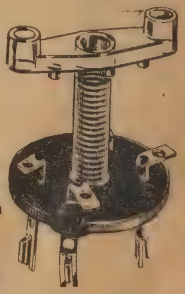

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FROM THE SERVICEMAN WHO TELLS

Considering the wide variety of subjects discussed in these columns over the years, it is rather surprising to find one about which I have said practically nothing. I refer to negative feedback, and particularly the more elaborate circuits as distinct from the simple plate-to-plate feedback resistor.

THERE is a very good reason for this—it is a part of the circuit which, once set, gives very little trouble and thus never invites more than a passing glance from yours truly. About the closest I normally come to it is when, like last month, I have to mock up the bench speaker to simulate such a system.

It is rather surprising, therefore, to find that this month's bag contains not one but two jobs which involved this part of the circuit. Both, quite frankly, still remain something of a mystery.

The first was a Radio, TV and Hobbies circuit, the Wide-Band Six described in February, 1954, and I first encountered it several months ago when the builder originally completed it.

Lacking a generator, he brought it to me for alignment, pointing out that the original article described an alignment procedure which was a little unusual. Being a wide range set, he felt it deserved something more than the rough "align it by ear" technique which often gets by with the more conventional sets.

WELL BUILT

Although I am often very wary of beginners sets which "only need to be aligned" I knew enough about the history of this set and the builder to imagine that there would be no serious snags. A glance at the chassis was sufficient to confirm my opinion. The owner had made a first-class job of it and there seemed little danger of trouble.

In the course of preliminary discussions about the alignment technique and the circuit in general I noted that the feedback system derived its signal from the speaker voice coil and commented on this fact, asking whether the feedback had been connected and, of course, whether it was the right way around.

The owner assured me that it was and I thought no more about it. The set had its own speaker and I simply connected the output meter in the usual way, completed the alignment in the manner prescribed in the original text and passed it back to the owner.

NORMAL BEHAVIOR

As far as either I or the owner could tell, with the speaker unbaffled, the set was behaving quite normally. Admittedly we were both more concerned with the alignment at that stage, but the fact remains that there was nothing obviously wrong with it.

And that was the last I saw of it for several months. Then the owner approached me again. "Could you tell me," he asked, "how much volume I should be able to get out of that radiogram before it distorts?"

Since it is not easy to describe just "how much" volume one should be able to get I could only make some general suggestions. I remembered that he was using a good quality imported speaker which was more sensitive than the average and reasoned that the maximum output, which would be around four watts, would be more than could be tolerated in an ordinary room.

I said as much, and added that a few hundred milliwatts is normally quite enough for an ordinary lounge room. Therefore he should not encounter overload difficulties unless he was trying to entertain the neighbors as well.

He shook his head. "Nothing like that at all. As soon as I turn it a little above ordinary room level it packs up. What I would call just a little louder than normal."

It was clear from his description that the maximum volume available was far short of what it should have been, even allowing for differences in our standards of "loudness". I suggested he bring it in and let me hear it.

And so, a couple of days later, we set the gear up on the bench and proceeded to give it the once over.

It was immediately clear that the owner was not exaggerating, for it was quite impossible to get anything like the normal maximum volume out of it. It was exactly as he had described it; at any volume above comfortable listening in an ordinary room there occurred a must unpleasant distortion.

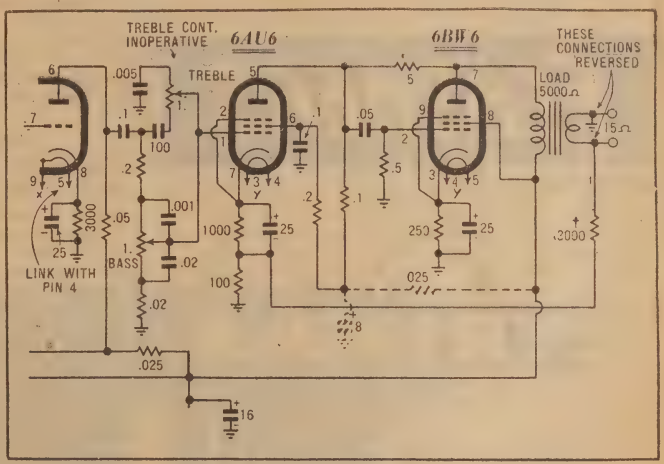
A quick check showed that the variable treble control did not appear to have much effect, although, without some previous experience of what it was supposed to do it was impossible to be sure whether it was working correctly or not. It was difficult to tell whether the bass control was working because the speaker was unbaffled.

The level at which the distortion occurred appeared to be quite critical, and the distortion, once it started, was quite severe; rather like the blocking effect which occurs when an output valve grid circuit is open or excessively high.

As a quick check, I reduced the aerial to a couple of feet of hook-up wire and advanced the volume control to prduce the same audio volume as before. Once again the same thing happened; at a certain critical level—acoustic level, that is—the signals packed up. What was more important, it was at exactly the same level as before.

A BIG AERIAL

I went to the other extreme and connected the largest aerial I had, retarded the volume control, and observed exactly the same effect at the same level. This process took only a few minutes, but it did es-



Portion of the Radio, TV and Hobbies circuit discussed in the text. Why was it possible to reverse the feedback windings without causing obvious oscillation? Since the owner omitted to try both arrangements he was unaware of the error.

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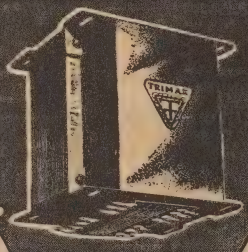

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tablish that the trouble was located at some point after the audio volume control. Had it been ahead of this point a change in signal level, as produced by the various aerial lengths, would almost certainly have altered the overload point.

This much established, I turned the chassis over and studied the audio section. On the assumption that something might be oscillating supersonically, I prodded various points with a screwdriver, held by the blade, in the hope that body capacity might be enough to alter the operating conditions and give a clue to the fault. This may not sound a very scientific approach, but it can be very effective.

Unfortunately, it didn't help much this time. I prodded the output plate, the driver plate, the grids, and other likely signal points, without affecting the performance in any way. Somewhat idly I wondered what would happen if the feedback was removed and proceeded to find out by shorting it with the screwdriver.

SURPRISE

While I had no fixed ideas as to what might happen to the distortion, I expected only one thing to happen to the overall level; with the feedback removed it would increase by quite a noticeable level. Imagine my surprise, therefore, when, instead of increasing, it decreased.

I checked again that I really was working on the feedback line, then double checked by disconnecting the line rather than shorting it out. The result was the same; with the feedback removed the set was less sensitive than with it on.

Although it seemed silly, I could only conclude that the feedback was positive, instead of negative, in spite of the fact that there was no obvious violent oscillation, as one would expect. It required only a few moments with the soldering iron to reverse the transformer secondary connections, taking the feedback from the opposite side. This time there was a pronounced drop in volume as the feedback was connected, and I knew I was on the right track.

Sure enough, the objectionable distortion had vanished and the volume could be turned up to much more than a tolerable listening level without any sign of distress. Also I was pleased to note, the treble control had "come good", and was now quite marked in its operation.

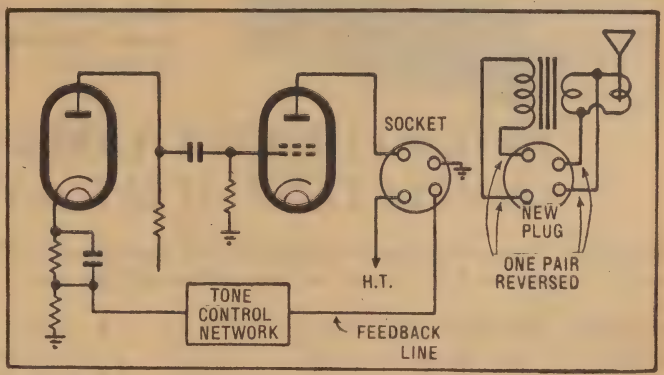
Needless to say, the owner was jubilant, since the last snag in his system had now been eliminated. He set off home with his gear, in joyful anticipation of a session with his favorite records, played, I suspect, at rather more than normal volume —at least until the novelty had worn off or his wife threatened to leave him!

MYSTERY

But just how was it possible for the original condition of positive feedback to have occurred? After all, we have been led to believe, both from written texts and our own experience, that such a condition is virtually impossible, since the system would simply scream its head off at a few thousand cycles. This would be particularly so in this case, where the amount of feedback involved was fairly high.

On the other hand, the owner was able to explain how it was that the faulty connection actually occurred. "I didn't try it both ways," he explained. "I simply wired the feedback line to the voice coil as I completed the wiring and before I switched it on. When I switched it on and it didn't squeal I assumed I had been lucky enough to strike it right way first time and I simply left it at that."

Which, interesting and all though it may be, still doesn't explain why it didn't oscillate. To be quite frank, I can offer no complete explanation. Two possibilities present themselves:



Apparently reversed in the process of replacing a plug this feedback system also failed to oscillate—at least immediately. Why it eventually decided to spill over must remain something of a mystery.

One, that the system was actually oscillating but at supersonic frequency. This could cause distortion by reason of the power wasted in supersonic oscillation, leaving little for audible signals.

Alternatively, the amount of feedback may not have been sufficient to cause sustained oscillation (though it would appear that it should have been) but was such that any moderately strong signal would shock it into supersonic oscillation.

Of the two I am inclined to support the latter theory. One reason is the extremely abrupt nature of the onset of distortion. Had the distortion been simply due to overload its onset would have been more gradual. As it was, I gained the impression that there was a major change in conditions whenever the distortion occurred.

MISSED OUT

Of course I realise that I missed out rather badly in not putting the CRO on the thing while I had it on the bench, particularly as there was more than a possibility that it would make a story. Truth to tell, I was so intrigued at finding the fault that the set was well on its way back home before it occurred to me that I still didn't know the full story to write into these pages.

Since I can hardly ask the owner to drag it all out of his cabinet again and back to my shop the full story may never be known.

The next case was one of those "unofficial" jobs which crop up from time to time. A near neighbor, who dabbles a little in the noble science, approached me with the complaint that his set had suddenly started to squeal. Although out of normal business hours I felt I had to be neighborly and help him out. (Besides, he's a motor mechanic by trade and I may want to cadge a free rebore in the near future.)

Anyway, we made our way up the road to his home and I asked a few preliminary questions as we went. It seemed it was a home-made set made for him by a friend, he not having yet reached the stage where he felt competent to tackle a full-size set. The circuit, I was told, was that of a well-known commercial receiver.

Then I encountered the set itself. It appeared to be a fairly elaborate single-ended radiogram, using a voice coil feedback system with a fairly complex tone control circuit in the feedback line. It appeared to have been quite well made.

I switched it on and waited for it to warm up. Sure enough, as soon as it did it gave forth a violent howl. I lifted the grid clip from the audio stage and the howl vanished, the system then appearing to have about normal sensitivity. But in no circumstances would it tolerate the grid clip back in place.

Under the chassis I traced out the feedback line while we waited for an iron to heat up. Although I had no difficulty in picking out the network in general I did not particularly relish tackling the tone control portion of it without a copy of the circuit. Not only was it a complex array of resistors and condensers but it was mounted in an inaccessible position in the chassis.

However, I decided to worry about that portion when—and if—I had to. In the meantime, the iron was hot and I lifted the feedback connection from the speaker socket. This time the set warmed up normally and commenced to play without any sign of oscillation, and it seemed that once again I was on the track.

POSITIVE AGAIN!

The next step, of course, was to reverse the chassis connection and try the feedback the other way round. As I expected, this caused a drop in volume, confirming my suspicion that the feedback was the wrong way round.

But how did it get that way? I suspected that my friend had been indulging in a little fiddling, which

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he had not thought worth while to mention. I asked him if he had made any alterations to the set, particularly around the speaker connections.

Yes, it seemed that he had. The original speaker plug had been cracked and he had decided to fit a new one, though he was sure he had wired it the same as the old one. In one sense I had no doubt that he had; where he had failed was in not appreciating the need to observe the polarity of the wires.

The speaker transformer was mounted on the speaker, a four-wire cable and four-pin plug being used to connect both the primary and secondary windings to the main chassis. Although each pair of wires was a different color, there was nothing to distinguish the two wires of either pair from each other. Thus it would have been quite easy during the process of changing the plug to confuse the polarity of either pair.

I was convinced now that this was what had happened and was about to deliver a lecture on the subject of positive and negative feedback, when the owner's next remark staggered me.

"But I did that a week ago," he protested, "and it's been going all right ever since. It only played up when I switched it on a little while ago."

MORE MYSTERY

I'm afraid I quizzed him pretty closely on that statement. It wasn't that I doubted his word, but the situation seemed so down-right silly that I couldn't help feeling there was some other alteration, probably quite insignificant to him, which he had made recently.

But if there was we couldn't locate it. As far as could be established, the speaker plug had been altered a week ago, presumably with reversed connections, and the set had performed almost normally ever since. I say almost, because the owner did recall that there had been a kind of distortion on loud passages, which he hadn't noticed previously.

Apart from that, there was nothing apparently wrong until the squealing match of an hour or so before. Which raises the question: Why did the set perform normally for a week after the altered connections, before it decided to oscillate?

I'm afraid that, once again, I can only speculate. One suggestion is that one or more of the resistors in the feedback network had changed slightly in value, sufficient to tip the delicate balance between near oscillation (as indicated by the distortion) and the real thing. Knowing the rate at which some resistors can drift, I would say that this was quite possible.

Another suggestion is that line voltage fluctuations could have been responsible, our supply being prone to rather severe fluctuations of late.

TONE CONTROL SETTING

Again it could have been a combination of these factors, plus a particular setting of the volume control and tone control, the latter in particular having some effect on the exact amount of feedback. Although I was unable to confirm that this was sufficient to effect such a change, it could well have done so under different line voltage conditions.

So there it is; mystery number two for the month.

However, there is one point which I consider worthy of comment. That is the doubtful wisdom of copying commercial circuits, using voice coil feedback circuits, unless the exact characteristics of the speaker transformer are known and can be duplicated.

These circuits are invariably developed by the firm's own laboratory using a ready-made transformer of known specifications or, more probably, one made in the firm's own winding department. On this basis, a degree of feedback will be chosen, together with a carefully tailored tone control circuit, which is never likely to become unstable in any condition of operation.

Since a large organisation would have no difficulty in ensuring that the transformers it used were always identical there would be little chance of trouble. Even if it did occur, due to some unforeseen circumstance, it would be quickly picked up in one of various tests which every chassis must undergo. During such tests, incidentally, a chassis having higher than normal sensitivity would be looked upon with just as much suspicion as one which was too low.

But for the home builder, with no more information than is available from the circuit and his limited test facilities, to take any old speaker transformer, simply on the basis of the impedance required, and expect to duplicate the performance of the commercial chassis is really asking too much.

OSCILLATION DANGER

Not only is it unlikely that he will get as good results but there is the very real danger that phase rotations, not present in the original transformer, will cause instability at one or both ends of the spectrum. Usually it is at the high frequency and in the supersonic region.

And before I leave the subject entirely may I be permitted to recall an incident from my factory days? (Well, I'm going to, anyway).

The firm for which I worked in those days used voice coil feedback on all its models and it was a particularly effective circuit. No trouble was normally encountered in the matter of reversed connections, since the firm made their own speaker transformers and the leads were clearly coded. Thus the wirers were able to wire them directly into circuit without the need for any trial and error connections.

But one day something did go wrong. If I remember correctly it was the speaker leads which had been reversed, meaning that the chassis proper was OK and had passed all the preliminary tests when connected to various bench speakers. Then it was assembled in a cabinet, along with the faulty speaker, and passed over to yours truly for its final test.

As I received the set the volume control was turned full up, an important point as we shall see in a moment. There was no obvious evidence of instability, but I imagined I detected a faint hum and put my ear hard up against the speaker grill to check this point.

Sure enough, there was quite a merry hum and, with my ear still against the speaker, I reached for the volume control and turned it down, intending to note whether the hum decreased also. The next moment I sincerely wished I hadn't. The speaker gave forth a squeal at a couple of thousand cycles and at a level of several watts.

For my ear, only inches from the cone, the level was somewhere around 120 db or whatever level is classified as the "threshold of pain" according to the textbooks. My ear did not fully recover for several days.

TAPPED CONTROL

And why did the system not oscillate with the volume control fully advanced? To answer that we must consider a few details of the feedback network. The feedback signals, after having come from the voice coil, through the tone control network, were injected into the audio system via a tapping on the volume control.

This was—and still is—quite a popular arrangement. The tapping was at a point representing about the lowest useful volume which the set would deliver. In other words, it represented a typical low level listening position. Since many people imagine that it is correct to boost the bass response for low level listening the feedback network was designed to have considerable bass boost, and this was most effective at this point, being the point of maximum feedback.

As the volume control was advanced the amount of feedback was reduced until, at full output, it was of a low order and insufficient (as I discovered) to maintain oscillation when the connections were reversed.

But as soon as I retarded the control the feedback—positive now—increased markedly and out came the watts—into my ear. Ever after that I made it a point of always testing the controls first if I had occasion to listen closely to the speaker.

Summing up all these cases, and, in spite of the fact that some aspects must remain inconclusive, I think we can find a moral: Never take a feedback connection for granted, try it both ways first.

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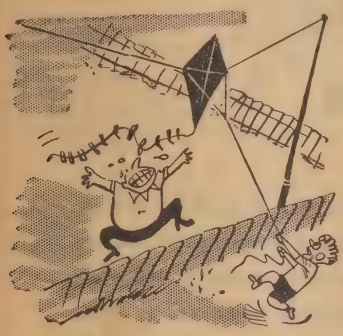
Here's your answer, Tom!

It does not matter how often one repeats essential facts about radio, there will always be the man who "has just started out" and asks the very same questions all over again. It is not surprising, therefore, that we find another question on aerials and wave-lengths this month.

MORE about that later, however. Other questions include stroboscopes and contact potential. Here is the first one:

At an exhibition a friend of mine saw a machine with which rapidly moving objects could be viewed, as if they were standing still. What is this machine and how does it work?

The machine your friend saw, Tom, is very widely used in industrial and scientific applications and is called a "stroboscope". Compli-



. . . and Children's Kites!

cated though it may seem, Tom, its principle of operation is extremely simple.

The basic idea is that if you project a very short pulse of light on to a fast-moving object, the object will not have time to move very far while it is illuminated.

If we now repeat this pulse of light every time the object reaches the same position, it will appear to be stationary. It goes without saying that only objects which move to and fro or rotate at a regular rate can be observed in this manner.

Although we see the object for a very short time at each flash, the image storing qualities of our eyes makes the image appear to be a continuous one.

ROTATING EFFECT

A very peculiar thing happens if the flashes do not occur in time with the movement. This is best illustrated by way of an example.

Imagine a rotating disc with a white dot painted on it, and a light which is switched on for a short period every time the disc completes one revolution. From the foregoing it will be obvious that the dot and the disc will appear to be stationary.

If, however, the disc is spinning at say 100 rpm, but the light is switched on 110 times per minute, the dot will be in a different position each time the light strikes it, and the disc will appear to be moving slowly backwards. On the other hand, if the flashes occur at the rate of 90 a minute, the dot will appear to be moving forward, because it will have moved forward one and one-ninth revolutions, by the time the next flash occurs.

In practical applications the light source is usually a gas discharge tube, very similar to tubes used in electronic flashes, or neon indicator lights. Both these tubes have one characteristic in common—that they do not "fire" or light up, until the voltage applied to their terminals exceeds a certain minimum, and extinguish as soon as the voltage drops below another critical level.

Furthermore, the lighting up and extinguishing occurs almost instantaneously.

The power to operate the tube usually comes from a source of variable frequency AC, such as an audio oscillator. The frequency has to be variable, so that the instrument can be adapted to any number of flashes to suit the rate of movement of the object to be observed.

TWO FLASHES

The peak AC voltage is usually just sufficient to fire the tube so that, for every complete AC cycle, there are two flashes, one for the positive, and one for the negative peak.

The oscillator dial, however, is normally calibrated directly according to the number of flashes.

As mentioned earlier, both science and industry use the stroboscope, where direct observation of rapidly moving parts is essential. For instance, a change in shape of rotating machinery — caused by centrifugal force and unbalance of components—can be detected visually, without the need of elaborate measuring instruments, or expensive test mockups.

It also enables the observer to obtain an accurate indication of the frequency of movement or the number of revolutions of revolving parts, without the need of attaching a special instrument to the machinery.

He simply adjusts the frequency of the flashes until the moving part appears to be stationary. The frequency can then be read straight off the oscillator dial.

In fact, stroboscopes are made, which are accurate enough to permit adjustment of watches instantaneously, a process, which takes several days, if not weeks to accomplish with conventional methods.

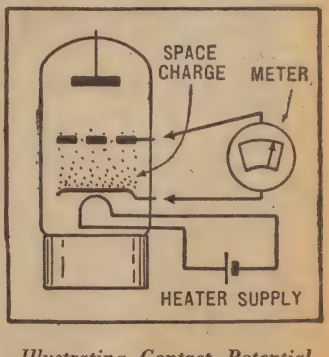
And now to the question we referred to in the introduction.

Could I receive short waves on a broadcast receiver, if I used a short aerial?

This time, Tom, the answer is definitely no. You see, the aerial is not particularly choosey what it picks up. In fact, it picks up anything and everything that happens to be "on the air", be it long, medium or short waves, atmospheric static, or the lawnmower three doors away!

Why, aerials have even been known to pick up flying foxes and children's kites!

It is up to the receiver to sort out this jumble, and pick out Captain Tenterhooks Adventures, or the latest overseas news broadcast, just as you want it. But, — and here is the catch — it can only make sense of those wavelengths, for which it was originally designed. It just does not respond to anything else.



Illustrating Contact Potential

The aerial is only there to pick up the signal and convey it to the receiver. From there on the receiver takes complete charge.

As you probably know, there is a certain frequency corresponding to each wavelength. What's more, there are so-called "tuned circuits" in the receiver, consisting of a capacitor and a coil, which show particular preference for one frequency or another, depending on the circuit values.

By means of the tuning control

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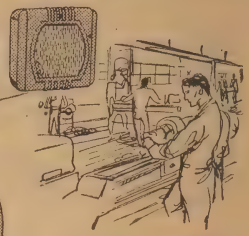

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on your receiver, you alter the amount of capacitance in the tuned circuits, causing them to respond to a different frequency — between certain circuits. So, with broadcast receivers, you can tune in any frequency within the broadcast band.

With a different set of coils you can receive a different band of frequencies or, in other words, a different band of wavelengths. The essential point is, that this new set of coils has to be installed or provided in the receiver before it can be used on other than the broadcast band.

In areas of relatively high signal strength the length of the aerial is not at all critical. A piece of wire around the picture rail is usually all that is required, sometimes not even that. However, where only one fixed wavelength is involved, it often pays to make the aerial length a certain fixed percentage of the wavelength, so that it shows preference for that particular wavelength, or, more exactly, becomes resonant at that frequency.

Thus the job of the tuned circuits in the receiver becomes easier and the aerial is less likely to pick up interference.

RESONANT AERIALS

The use of resonant aerials is standard practice these days on all VHF, UHF and television frequencies.

So it looks like, Tom, you will have to invest in a dual wave receiver or else modify the one you have.

And so we come to a subject which does not seem to be mentioned too often these days. Here is the question:

Could you please tell me what contact potential is?

To answer this question, we better take a practical example, Tom.

If you take a valve — almost any kind of valve — connect the heater to the heater supply, but leave all other electrodes unconnected, there will be a measurable potential difference between the cathode and the control grid. This, in spite of the fact that these electrodes are not connected to any voltage source, but simply left "floating".

This potential difference is referred to as "contact potential". But where does it come from?

You probably know, Tom, that when the cathode of a valve is heated, electrons are "boiled" off its surface. This phenomenon is generally referred to as thermionic emission. The important thing to remember is that the electrons are emitted, whether or not potentials apart from heater voltage, are applied to the valve.

SPACE CHARGE

If the emitted electrons are not attracted by anything, they float around in the vacuum between the cathode and the nearest electrode, forming what is called a "space charge". However, the grid being close to the cathode, many of them settle on it, forming a negative charge. This process continues until there is a sufficient number of electrons on the grid to repel any further electrons from "landing".

At the same time, electrons are taken away from the cathode, resulting in a positive charge being left on it.

If we now connect a meter—preferably a high resistance type, such as a VTVM—there will be a return path provided for the electrons, and they will flow back to the cathode through the meter resistance, registering a voltage on the meter.

With a high resistance in the return path, comparatively few electrons at a time are permitted to return and these are replaced continuously from the cathode. The voltage appearing on the grid, therefore, remains quite high.

A lower resistance, say 50,000 ohms, in the return path will allow the electrons to leak away much faster, thereby reducing the charge on the grid and with it the apparent voltage.

Still lower values of resistance may make the contact potential too low to be measured.

To a lesser extent, other electrodes, such as plate and screen also show a contact potential, but it is usually the electrode nearest the cathode, which is most affected.

MEASURING AC

Diodes exhibit such potentials on their plates, as there is no other electrode to accept such stray electrons. This is where contact potential assumes considerable importance.

Diodes are often used in sensitive measuring instruments for the measurement of AC. The AC is rectified before it is passed on to the indicating meter, and any other DC, such as the contact potential, is passed on with it, falsifying the true reading. In such cases it is necessary to apply an equal DC voltage of opposite polarity to the diode, to balance out the misleading voltage.

In general, the closer the electrode spacing, the more pronounced the effect becomes. It is, therefore, obvious that miniature and high-Gm valves suffer most from the effects of contact potential.

Sometimes it is possible to make good use of the effect, by using a high grid resistor, and allowing the contact potential to provide the necessary operating bias for the valve.

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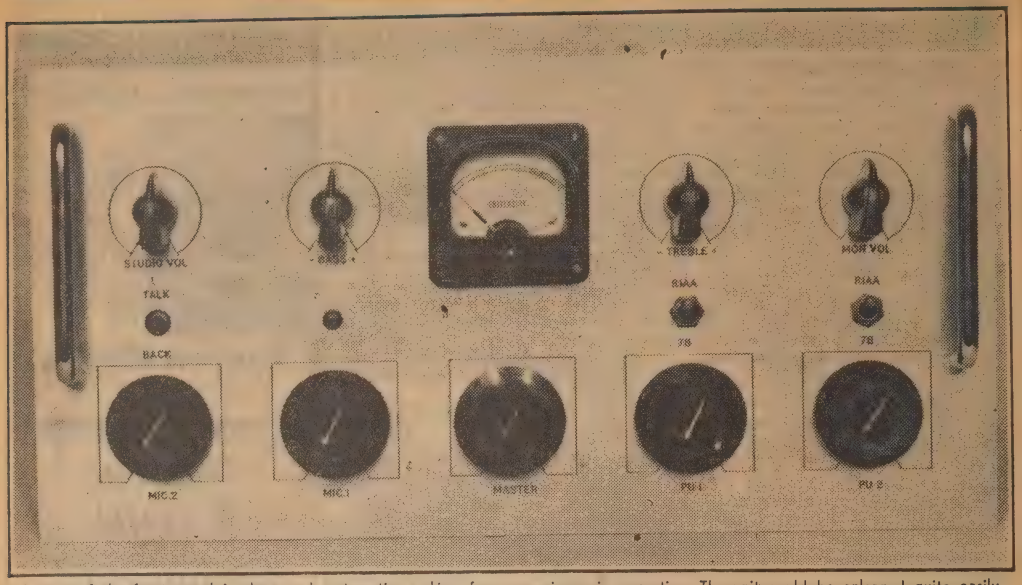


Layout of the front panel is clean and systematic, making for convenience in operation. The unit could be enlarged quite easily to accommodate another Mic. and another PU channel. The meter is a standard 3"-square 1-milliamp movement.

A 4-CHANNEL MIXER UNIT

Perhaps you're the "sound man" for an amateur dramatic group; perhaps you make customer recordings; perhaps you produce commentaries for strip or striped films; perhaps you just like fiddling around with audio gadgets! Well, here's something that will be sure to appeal to you—a mixing console using the kind of parts you can get together most easily.

by Neville Williams

THE circuit as it stands may be just the thing you're looking for. Alternatively, it may provide you with ideas which can be worked into a mixer of your own design. It is even capable of being expanded quite readily.

In our last issue, we had a good deal to say about the components and techniques which an amateur audio enthusiast has to use.

We explained that he cannot afford the expensive array of transformers, lines, jack fields and so on that are part and parcel of a professional sound studio; that he has to use microphones and pickups which would be scorned in professional studios; that he must make do, in short, with very ordinary-looking components and circuits.

GOOD RESULTS POSSIBLE

However, that does not mean that an amateur enthusiast cannot produce quite excellent results in his particular field.

By avoiding unnecessary frequency loss and distortion and by choosing the best pickups and microphones that are available to him, an amateur can produce tapes, striped film commentaries or just plain amplified sound, for which no apology need be offered.

Our purpose here is to resolve one of his main problems—how to amplify and bring together the signals from various microphones and pickups, so that they can be fed into a common recording or reproducing device—whatever it happens to be.

And here the difficulty begins. How many microphones and pickups are likely to be required and of what type? What are the "devices" which an amateur enthusiast wants to feed? At what level? What extra facilities does he need? Monitoring? Level Indicator? Talkback? Or what?

No two people are likely to return the same combination of answers to these and other possible questions and no one design that we might produce would be ideal for everybody. Some will want lots of facilities, others very few.

In the face of this difficulty, we adopted what seemed to be the most logical course. We included in our design all the ordinary facilities that we've wished for over many years of doing this and that in the audio field. At the same time, however, we've tried to avoid unnecessary duplication or over-expensive components.

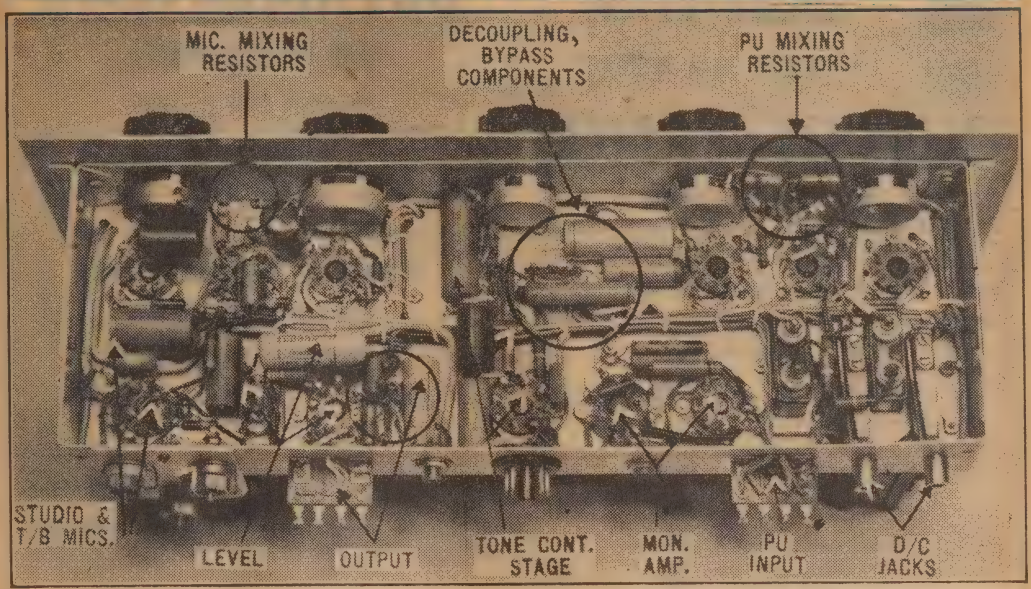
READILY AMENDED

Finally we designed the circuit in such a way that whole sections of it could be amended or omitted without unduly upsetting the rest. The truth of this statement will become apparent when the circuit is examined later. It is quite "versatile" in regard to both facilities and components.

Here are the facilities which the design offers in its original form:—

(1) Input channels for two microphones and two pickups. The latter may be either magnetic or crystal

UNDERNEATH VIEW OF THE MIXER CHASSIS



A lot of care is necessary in the wiring to forestall interaction between different groups of components. Most of the interconnecting leads are run together down the centre of the chassis and are laced for neatness and rigidity.

and compensation can be switched for either 78 or microgroove characteristics. All channels feed through independent mixers to a "Master" gain control.

(2) Both pickup channels can be "captured" for external inputs by means of double circuit jacks.

(3) A compensating stage provides continuously variable bass and treble boost or cut.

(4) Low impedance output circuit from a cathode follower stage.

(5) Level indicator meter.

(6) A normal output signal of 1-volt RMS.

(7) Four-watt monitor amplifier.

(8) Talk-back facilities to stage or studio.

(9) Four-watt monitor to stage or studio for pickup channels only.

(10) Panel layout arranged for convenient operation.

THE CIRCUIT

To see how these facilities are provided will require a lengthy and detailed examination of the circuit. While so doing, we shall take the opportunity of commenting on the design generally and making any relevant suggestions about alternative components and circuit arrangements.

Perhaps it may be as well to explain, at the outset, that the unit was originally commenced over twelve months ago as a purely personal venture on the part of the writer. Rather than draw on a limited supply of miniature valves, it was decided at that stage to use some of the many octal-based "-GT" types, which the writer—like most other enthusiasts—had collected over the years.

When it became apparent that other folk would be interested to read about such a unit, it raised the question as to whether a new start should be made, using modern miniature types throughout. (What a time to think about it.)

But then we reasoned that readers might want to save money, too—so we went ahead on the original plan, realising that miniature valves could be substituted by individual constructors, according to their own ideas and resources. So for the circuit:

The two microphone channels feed directly to the grids of preamplifier valves, with 5-meg. resistors to earth. These serve as grid returns and as a suitable load for most crystal pick-ups. The resistors can be reduced in value or shunted externally, if a different value of load is required for other specific types of microphone.

The valves originally installed in the preamplifier sockets were ex-disposals 7193's. This apparently strange choice is explained by the fact that these valves are really modified 6J5 triodes with the grid (and plate) connections nicely remote from the heater wiring.

VERY CHEAP

What is more, they have been available and are still available for prices ranging up to 2/6 each. On this basis one can afford to buy a couple extra and pick out the ones exhibiting the lowest microphony.

By the same token, any other general-purpose triodes could be used if one has access to enough of them to allow the best ones to be selected. The same circuit constants could be employed with such valves. Note that we have specified a high value cathode bypass as a precaution against hum injection at this point.

The use of triode preamplifiers pre-supposes the use of microphones having fairly high output, notably one or other of the wider-range crystal inserts.

With loud sounds or under close-talking conditions, these will deliver a peak output of over 150 millivolts, and from 30 to 50 millivolts under more average conditions.

Since the maximum input sensitivity of the unit with triode preamplifiers is about 3 millivolts RMS, it means that a crystal insert microphone can be used under such average conditions with the channel gain and master gain controls at about half setting—and therefore with ample reserve.

PENTODES RECOMMENDED

For lower-level microphones or more remote sound pickup, pentode preamplifiers could be substituted to advantage. The 0.1 meg. plate loads should be retained, but the screen and cathode resistors proportioned to satisfy published conditions.

Allowing for the fact that the two screens and two cathodes are connected in parallel, a 0.25 meg. screen feed and a 1000 ohm cathode resistor would be near enough for most types.

Ordinary pentodes like the 6SJ7, 6SH7, 6AU6, 6N8, &c., should not be used unless you have enough of them on hand to pick out those least afflicted by microphony.

The logical course of action, where new valves have to be purchased, would be to instal low-noise miniature pentodes, such as the Z79, EF86 or the older 6BR7. By and large, these valves can be relied upon to be free from microphonic effects and there is no need to fiddle with sprung socket mounts, &c.

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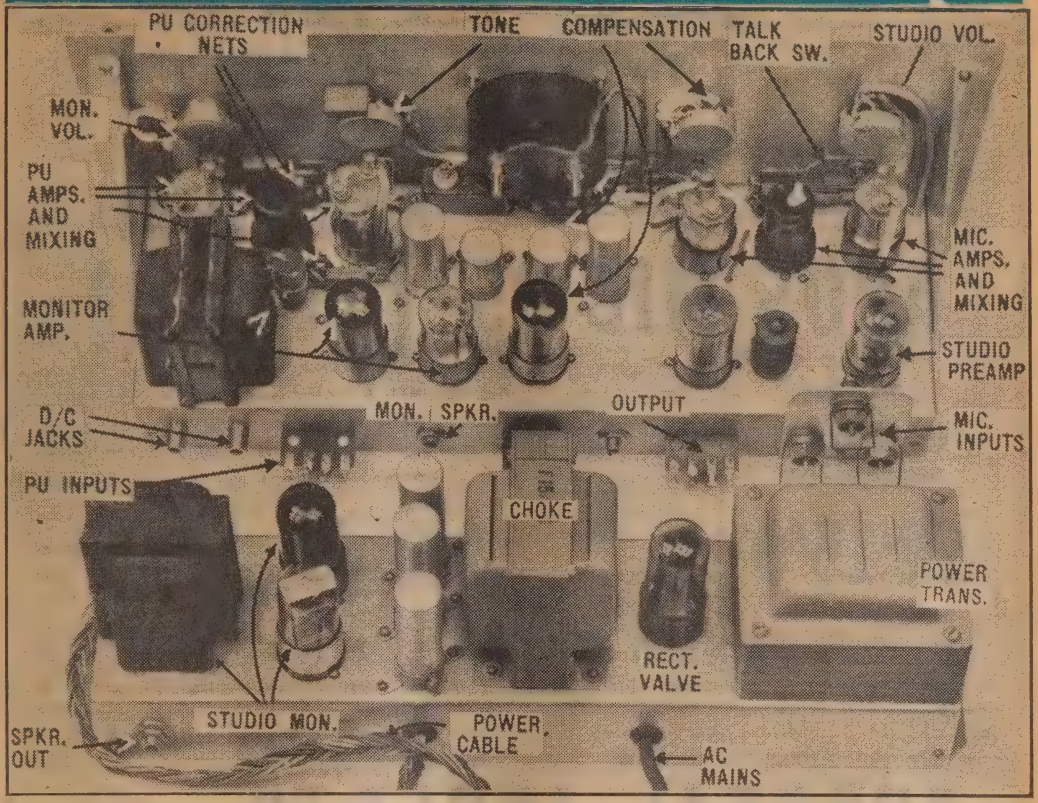


A rear view of the mixer unit and its associated power supply. The two valves at the left-hand end of the supply, together with the transformer, comprise the talk-back and/or programme monitor amplifier. Note the input and output connectors along the rear edge of the mixer.

It must be realised, of course, that such extra gain will only be useful in the preamplifier stages if due care is taken to prevent hum injection. In the amplifier, this will call for extra care in the placement of leads and possibly some experiment with the heater voltage and heater return for the initial stages.

External to the unit, it may necessitate some experiment with earthing, with placement of microphone cables and possibly the use of twin, balanced shielded cables instead of the more usual single-shielded variety. Another whole article could be written on such matters.

RESISTANCE MIXER

Getting back to the circuit, the signal output from both microphone preamplifiers is fed via a resistance mixer circuit to the grid of the subsequent stage. As explained last month, this involves a loss of about 6db, which is duly allowed for in the overall design of the unit.

If desired, a third microphone channel could be installed and mixed into circuit in the same way. (See figure 3e, last month.) The extra insertion loss would have to be taken into account and would just about dictate the use of pentodes in the three preamplifier stages.

However, we decided against using more than four channels in the original unit, partly because of the additional complication and partly because it would have involved using a much larger chassis and panel. You will have to make up your own mind on this point.

The two pickup input channels also have separate preamplifiers which, once again, are shown as triodes. The 1.0 meg. resistors in the grid circuits are nominal values and would normally have to be shunted down to something less than 0.1 meg. to provide proper loading for the pickup.

A compensating network is built into the plate output circuits and is so arranged that, by the flip of a toggle, it can be changed from a nominal 78 to a microgroove characteristic, as indicated by the curves on page 57.

No attempt was made to provide a more detailed selection of curves because, in practice, a panel operator just doesn't have the time to analyse every disc that goes on to the turntables.

An approximate correction which is used is much more effective than a near-perfect one that is abused or ignored.

Pickup input for full output at 1000 cps and with channel and master gains full on is about 35 millivolts, so that the sensitivity is high enough to work with medium output magnetic pickups. Alternatively, crystal pickups could be used, operating into a load between about .05 and 0.1 meg, according to their bass ouput.

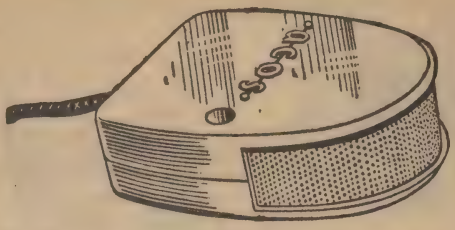
EXTRA GAIN?

If the intention is to use low output magnetic pickups as, for example, the variable reluctance variety, pentode preamplifier stages would be necessary and the same remarks would apply as for the microphone preamplifiers already discussed.

The microphony problem is not quite as severe, although it must be remembered that the stages still give full gain through the compensating network at the bass end.

Output from the compensated preamplifiers passes to the respective gain controls through double circuit jacks, so wired that the insertion of a plug breaks the internal circuit and allows a signal to

(Continued on page 55)



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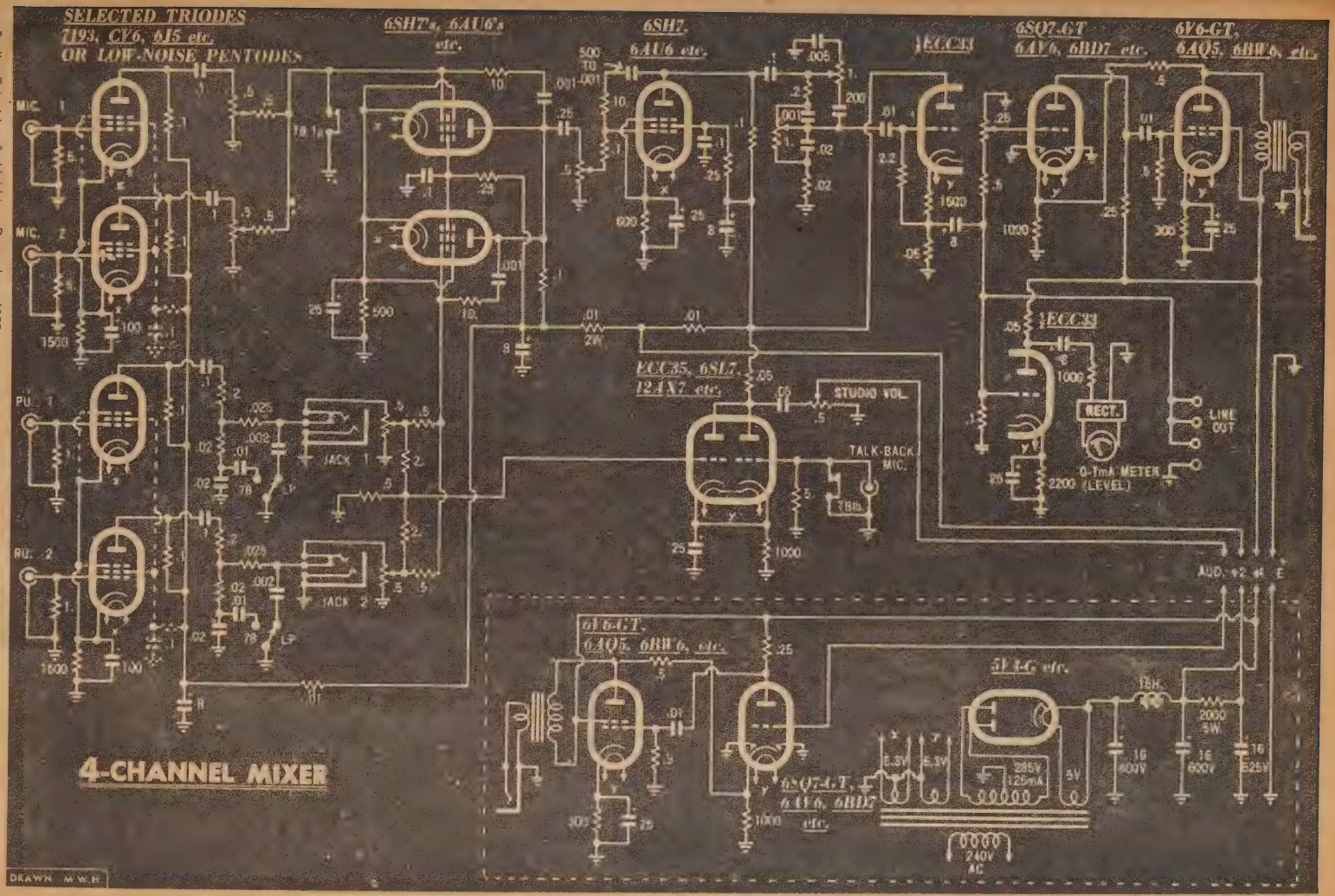
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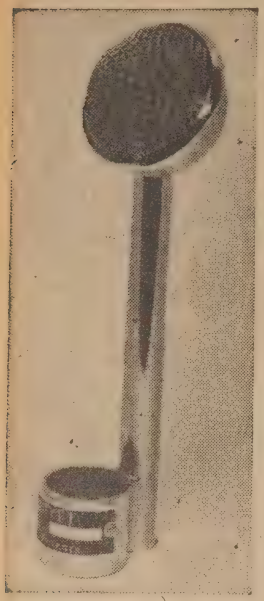

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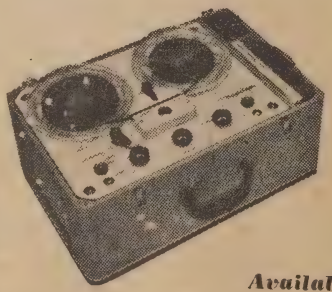

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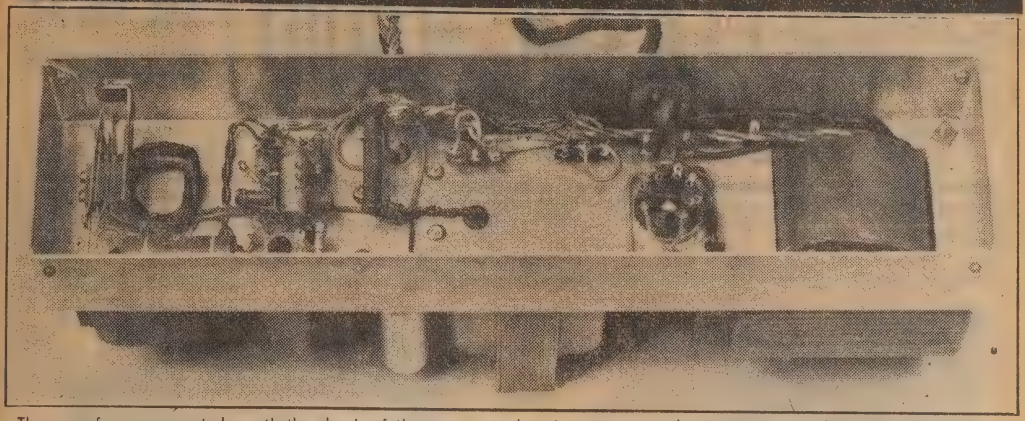

There are few components beneath the chassis of the power supply unit. A separate chassis is necessary, however, to prevent any trouble from eddy current effects. The jack at the left is the voice coil outlet for the studio speaker.

be fed directly to the gain control from an external source.

This is a purely optional feature, but well worth including, because it provides a convenient path by which a tape recorder, a telephone line, a radio tuner or even an auxiliary mixer may be patched into the main console. Input sensitivity at this point is again about 35 millivolts with gain controls at maximum.

And here the first major omission can be made from the basic design.

If crystal pickups only are to be used, the two pickup preamplifiers could be omitted, together with the compensation circuits, and the pickups fed directly into the 0.5 meg. gain controls. Bass boost will be achieved automatically, while the treble characteristics will depend on the response of the pickup and the record, exactly as in a conventional radiogram.

Alternatively, an extra pickup channel could be added, with or without the preamplifier, by using a three-section mixer. Or, yet again, one or more of these channels could be used for microphone input by reverting to the circuitry of the microphone preamplifiers already discussed.

PENTODE MIXERS

As it is, however, the microphone and pickup channels feed respectively to the grids of two pentode valves, with plate, screen and cathode circuits connected in parallel. The combined outputs appear in the composite plate circuit.

A feedback loop operates around the two mixer valves with beneficial effects, as under:

(1) It limits distortion in the parallel plate circuit.

(2) It operates against noise generated in the stage and makes it possible to use selected 6SH7 pentodes, which are available cheaply from disposals dealers. The 6AU6 can also be used without circuit change.

(3) It lowers the input resistance to the stage and obviates any interaction between the various mixing controls. In practice, the interaction amounts to less than half a decibel under the most extreme conditions.

Overall gain of the composite stage, including the insertion loss of the mixing circuit, is about seven or eight times. Due to the presence of feedback, this figure is obtained either with high Gm types like the 6SH7 specified, or with more modest valves like the 6SJ7. Obviously a low-noise pentode could be used without sacrificing gain.

Actually this much of the circuit —6 valves in all—could be extracted and built up as a basic mixer-preamplifier, feeding into the "pickup" channel of some existing equipment. As already explained, it could readily be expanded to accommodate up to six channels, disposed as required.

OUTPUT IMPEDANCE

The output impedance from the composite plate circuit is low enough to preclude any special difficulties with connecting leads.

In the original unit, however, the master mixer feeds into a universal tone compensating stage, using familiar principles to boost or cut the bass or treble quite independently of each other.

Such a facility is often very valuable. It can mask the noise on poor recordings, offset the most obvious weaknesses of "amateur" voices, compensate for known deficiences of the device being fed, produce artificial reproduction effects and so on.

If conventional tapered controls are used and are wired so that the "boost" in both cases is clockwise, it will be found that level overall response will be obtained with both controls in their approximate centre positions. However, since they are quite smooth in operation and continuously variable, they can be manipulated at all times to give the best overall balance, without interrupting the program.

It is noteworthy that a local feedback loop is also used around this stage. It markedly improves the linearity and output voltage, so that overload is not approached within the intended operating conditions of the stage.

The use of feedback lowers the input impedance quite markedly and a large input coupling capacitor is specified, as a result, to prevent bass attenuation with the gain control advanced. Additional compensation for any residual bass loss can readily be arranged by limiting the value of the feedback blocking capacitor, as indicated in the circuit.

The gain of the tone compensating stage, input to output, is a little over three times. Microphony is not likely to be a serious problem in this stage.

Once again, the output could conceivably be taken from this point to an external device, and the rest of the circuit ignored. However, a low-capacitance coupling lead would be necessary and the input resistor at the far end must not be less than 1.0 meg., if the bass boost circuit is to function correctly.

However, if the original circuit is followed up to this point, it would appear highly desirable to go one step further and to add the cathode follower, as shown. This involves half an ECC33, but any comparable medium-mu triode or triode-connected pentode could be substituted without change to the circuit constants.

The output impedance from the cathode follower is low enough to feed any likely number of associate devices, through any likely amount of cable, without appreciable shunt losses.

OUTPUT LEVEL

The design of this output circuit involved reaching two major decisions. The first involved output level.

Professional consoles are usually designed to deliver a standardised power level into a 600-ohm circuit, with an adequate safety margin against overload and occasionally the ability to supply extra level to offset possible line losses.

Closely dependent on this is the design of the level indicator circuit which, these days, follows a quite standardised practice.

However, the average amateur enthusiast does not require this order of power and voltage and, to provide it would involve extra circuit complication.

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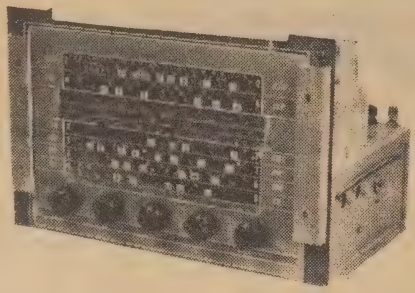

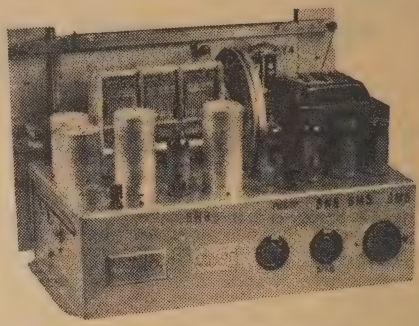

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Accordingly, we adopted what would seem a realistic approach in recognising that the average private individual is not likely to want anything more pretentious than enough signal to feed one or more high impedance inputs at "pickup" level.

Accordingly, we settled for a condition where normal line level from the console is 1 volt RMS, enough to drive even an insensitive amplifier to high output. If special line facilities are required, we suggest that a separate small repeater amplifier be provided for the purpose.

No attempt was made to duplicate the standard VU meter circuit, for the reasons already mentioned and because of the expense involved.

We talked the matter over with a local meter manufacturer, who suggested that a modern 3-inch square type meter would be sufficiently fast in its action and sufficiently free from overshoot to give a reasonable assessment of signal level.

ORDINARY METER

It certainly seemed to work out this way and the original console carries a standard 3-inch square meter with a plain 10-division scale.

The meter is actuated from the plate circuit of a triode—actually the other half of the cathode follower valve already mentioned. The valve will supply just enough power to operate the meter circuit, and, by reason of saturation on excessive signals, provides some automatic protection for both meter and rectifier.

A 5-milliamp meter rectifier is to be prefered for the purpose, but, once again, we found it possible to save expense by using a large telephone-type rectifier. Linearity is surprisingly good.

The series-feed resistor to the rectifier will need to be chosen so that the meter reads to some convenient value with the desired level of output signal. We arranged the original unit so that the meter read 0.7 of maximum deflection with a 1-volt RMS signal on the line output terminals. The last three divisions of the scale were tinted red to indicate the arbitrary "overload" region.

The level indicator could, of course, be omitted but its inclusion and correct calibration guarantees that the console will never be used inadvertently under conditions where the output circuits are overloaded. This might easily occur if the associate devices are operated with their input controls turned too far down.

HOW TO OPERATE

The idea is always to operate the console so that the signal peaks up toward the "overload" region, indicating a peak output of not more than about 1 to 1.5 volts.

This output is then fed into the "pickup" channel of the associated amplifier or recorder and its gain control adjusted so that the right peak output is delivered to the speakers or record head, as the case may be. All subsequent monitoring is then done at the console, by means of the level indicator.

This much completes the basic function of amplifying and mixing the various input signals and many constructors might be willing to "call it a day" at this point. The program might well be monitored by listening to the net result in the hall or via the in-built speaker of a conventional tape recorder.

But what if neither course is convenient?

To obviate any such difficulty, we have provided for a program monitor amplifier, which would normally be for the exclusive use of the control operator.

It is a simple two-stage affair, which will be as good as the output transformer built into it. It should ideally feed a well-baffled speaker, so that the operator can judge what the final balance is likely to be under typical listening conditions.

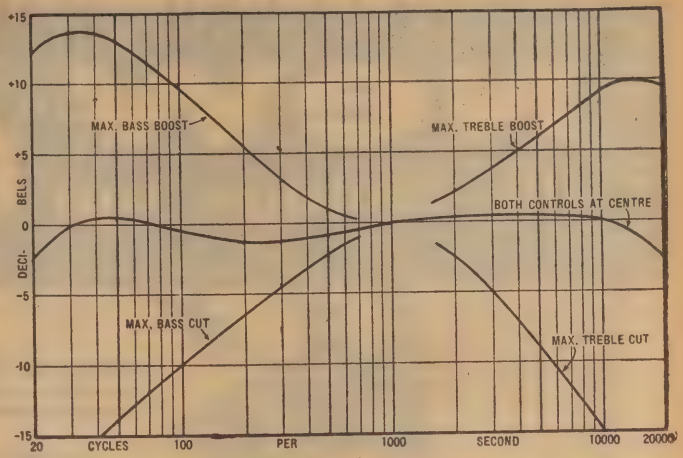
Alternatively, a pair of good-quality headphones can be plugged in and the program monitored in silence.

The input to this amplifier has been deliberately limited, because it never has to produce more than its rated maximum output power and it always has available to it a signal which has been preadjusted to an approximate 1-volt level.

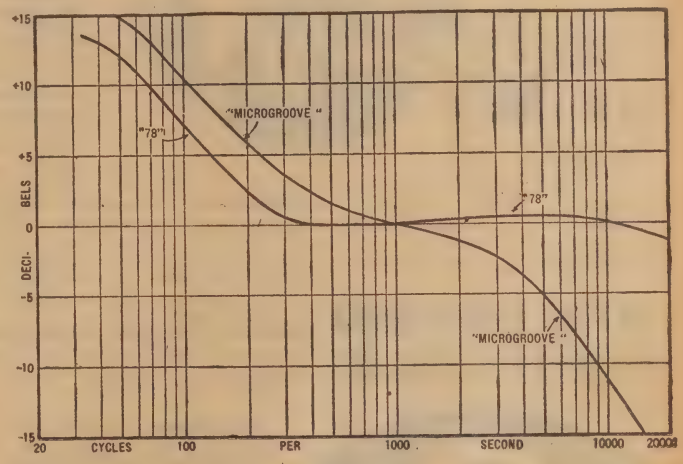
Limiting the input in this way eases the difficulties which might arise with motorboating, when all controls (including bass boost) are turned full on.

The remaining major addition to the design will normally be required for studio work only, where actors may wish to hear sound effects or

CURVES OF FREQUENCY RESPONSE

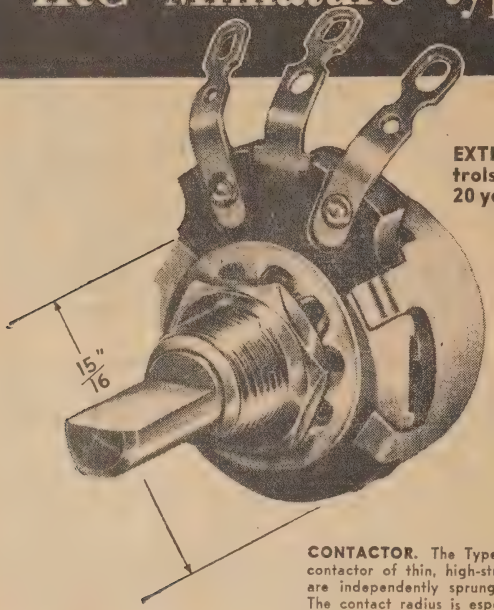


Curves of continuously variable controls are often somewhat confused by interaction in the 1Kc. reference region. These curves give some idea, however, of the limits of control and also the overall response with both controls set at the mechanical centre point.



The measured response through the pickup channels, including the effect of the variable compensation controls at the centre setting. The use of bass-boost capacitors on the low side of tolerance would move the curves slightly to the right.

New IRC Miniature type Q Control



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FEATURES AND SPECIFICATIONS

CONTROL BASE IS MOULDED of high strength first grade bakelite which eliminates mechanical distortion and moisture absorption associated with the use of punching bakelite. The base recesses assure accurately aligned parts and moulded voltage baffles are provided between the terminals and between the element and cover.

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CONTACTOR. The Type Q Control employs an I.R.C. patented, one-piece dual contactor of thin, high-stress alloy. Contact points are held on a radius line but are independently sprung. Passivating treatment maintains proper surface finish. The contact radius is especially developed for stable noise-wear characteristics.

COLLECTOR RING. A single-unit collector ring and centre terminal is made of silver-plated brass with special finish. This is snapped and locked in position over moulded boss of control base.

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bridge music, or, alternatively, receive spoken instructions from the director or panel operator.

It involves the use of another 4-watt amplifier, with speaker located in the studio, a preamplifier valve and a talk-back microphone, which can be a cheap crystal type.

If only sound effects and music are to be heard in the studio, the signals must be extracted directly after the pickups and before mixing with the microphone inputs. Our original intention was to pick the signal off the grid of the lower 6SH7 mixer but mic. signals are also present at this point, at low level, due to the common feedback circuit.

Accordingly, the signals are taken directly from the moving arms of the pickup faders and led to one grid of a twin triode preamplifier. A resistor from this point to earth lowers the impedance of the grid circuit (minimising treble loss) and also provides some adjustment for maximum signal level.

STUDIO CIRCUIT

From the plate circuit of the preamplifier, the signal passes through a gain control to the studio amplifier. In practice, the music and sound effects can be heard at any required volume through this channel without any hint of signal originating in the microphone channels.

For talk-back, the microphone output is fed into the alternative preamplifier grid, the circuit normally being shorted out by the spring-loaded switch section denoted as TB1b. The other section of this switch (TB1a) is normally open and is wired between the studio mic. circuit and earth.

Pushing the spring-loaded button shorts the studio microphones, thereby preventing feedback, opens the panel operator's microphone and allows him to talk back through the same amplifier which carries the music and sound effects. Ideally the output from the two sources should be balanced at some convenient level by varying the resistor mentioned above.

And, finally, there is the power supply. For the most part it is conventional and requires no special comment. However, the decoupling system has been worked out carefully to minimise the risk of motorboating, which is not unlikely with six stages operating in sequence from a common rectifier and filter.

PLENTY OF "C"

The amount of capacitance used is considerable, but can hardly stand to be reduced.

Conventional heater wiring is shown, but, on completion of the unit, one should be prepared to experiment with heater returns, earthing either side or the centre tap to chassis or returning them to a positive point, whichever proves to give the lowest over-all hum level.

Physically, the construction of the unit is a rather onerous task which should not, under any circumstances, be undertaken by a novice. It is complicated by the fact that the panel layout must be absolutely logical and systematic, irrespective of what problems this might pose in fitting in the associated circuitry.

Since it is quite hopeless to observe any rules about single point earthing, &c., the chassis must be completely free from eddy current problems. For this reason, we suggest the use of a heavy-gauge aluminium panel and chassis, with a separate power supply as an absolute must.

By story and pictures we can give you some idea of how to lay out an equivalent console, but inevitable variations will still demand a good deal of care and forethought on the part of individual constructors.

The golden rules might be summed up this way:

(1) Keep as short as possible all the active signal leads you can.

(2) Those leads you can't keep short, run in low capacitance cable.

(3) Try to maintain separation between groups of components associated with input and output circuits.

The front panel of the original instrument measures 18in x 9in, the main gain controls being disposed along the bottom edge and centred 2¼in up, so as to be at convenient height above the table top. In order, they are marked (left to right). MIC.2, MIC.1, MASTER, PUI and PU2.

Above the two pickup faders are toggle switches marked (up) "RIAA" and (down) "78". The networks which these switches control are assembled with miniature components on 8-tag strips and mounted above the chassis near their respective valves. There really isn't room for them underneath.

Above the MIC 1 control is an indicator bezel, while the TALK BACK button is located in the corresponding position above the MIC 2 fader.

This talk-back switch had to be fabricated for the purpose from an earphone jack, because there was no room for a long switch to protrude back from the panel. You will have either to solve this one in similar fashion or else move one of the preamplifier valves aside to make room for a larger switch.

TONE COMPENSATON

Bass and treble controls are arranged either side of the level meter (bass on the left) and the associated components assembled on another tagstrip mounted above the chassis and just below the level meter. This avoids overcrowding the underside of the chassis, obviates possible feedback problems and also keeps the active leads to the controls fairly short.

The STUDIO VOL. control is at the upper left corner of the panel and the MON. VOL. at the right, both connecting to their respective circuits through long shielded leads, passing down through the chassis.

A couple of nickel-plated handles, which pass through the chassis support brackets, set off a rather neat panel layout.

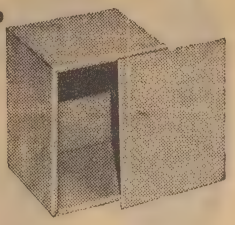
Dimensions of the chassis are 16in x 5¼in x 2in, which is large enough —but only just—to accommodate all the components. It is set part way up the panel so that, when finally installed in a desk cabinet, the panel can tilt back for convenient operation.

The four preamplifier valves mount directly behind their respective faders, so that their outputs can couple readily to the active terminals. Small tagstrips provide anchor points for the B-plus feed to their plate (and possibly screen) resistors.

We used chassis-mounting cathode

(Continued on Page 61)

METAL UTILITY CABINETS



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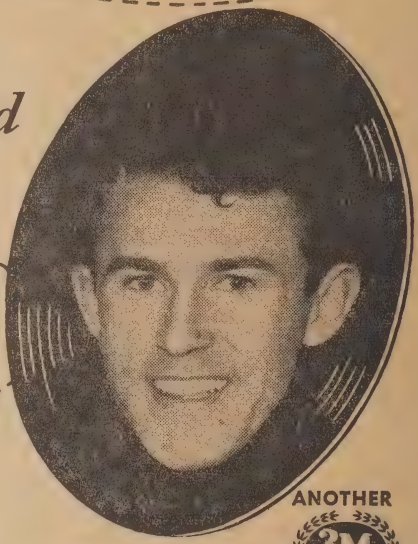

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M42RT94

A 4-Channel Mixer Unit

(Continued from Page 59)

bypass capacitors to save space underneath.

Input circuits to the preamplifiers are along the rear of the chassis and wired to the grids by shielded leads. Shielded connectors are provided for the microphones but ordinary tagstrips for the pickups.

The two mixer valves mount between the respective pairs of preamplifiers, with the grid pins so placed that the half-meg feed resistors string directly between the grids and the centre lugs of the faders.

Both plates connect by shielded leads to a common anchor point near the centre of the chassis, the signal being carried forward through a .25mfd coupling capacitor to the master gain control and thence back to the tone control valve in the rear centre position.

OUTPUT CIRCUITS

The twin triode, which serves as cathode follower output and meter amplifier, is alongside the tone control valve, its grid being fed by a shielded lead from the control circuits above the chassis. Components serving this stage should otherwise be grouped closely around the socket and kept away from the mic. input connectors.

The talk-back preamplifier can logically be mounted in this corner of the chassis, close to its own mic. input socket and handy to the talk-back button.

Signal input from the pickup circuits must be conveyed to it through a long shielded lead, but this should not cause any special difficulty. The studio monitor is not intended anyway as a high fidelity outlet, though there is no point in tolerating undue loss.

STUDIO MONITOR

The actual power amplifier associated with the studio monitor and talk-back circuit, is located on the power supply chassis and the circuit diagram shows a shielded signal lead carried through the power input socket to the grid of the relevant stage.

At the other end of the chassis there is ample room for the program monitor amplifier, including a good quality output transformer. There may be occasions when this four or five watts of power would be sufficient to cope with modest PA requirements, although it is not intended primarily for this purpose.

POWER CHASSIS

Dimensions of the power supply chassis are 16in x 3½in x 2½in, the intention being that the power supply should be housed behind the console, with just enough room between them to facilitate the connection of plugs, leads, &c.

Power is conveyed to the main chassis by a twisted lead, terminating in a female octal plug. This lead carries two sets of heater connections, earth, two B-plus connections and the signal lead to the studio amplifier.

It is ultimately planned to mount both console and power supply in a rectangular cabinet, which will be roughly the size of a portable tape recorder.

It is envisaged that a small monitor speaker—for non-critical work—can be mounted in the removable lid, along with a pair of dynamic phones and possibly a talk-back microphone.

TALK-BACK SPEAKER

By providing this speaker with enough cord, it could alternatively be used for talk-back purposes, monitoring being done either by phones or a second, more effectively baffled speaker. The use of jacks for both amplifier outlets makes possible a convenient interchange of functions.

The best method of connecting pickups and external devices to the console is best left to individuals. Some will prefer terminals, others a row of simple jacks mounted on the side of the wooden cabinet.

Power connections for turntables could also be mounted on the cabinet, but these are all matters which individual enthusiasts will be able to resolve for themselves.

What we have said, should give you plenty to go on with.

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WHY GRAMO MOTORS ARE NOISY

Most readers are aware of the fact that poor quality turntables can introduce a lot of noise into the output of an otherwise satisfactory amplifier system. This article explains the reasons for this noise and the meaning of the terms Wow, Flutter, Rumble and Hum.

FIRST of all there is "Wow", that slow rise and fall in pitch, which is so very obvious on sustained piano chords.

Wow is caused by the turntable accelerating and decelerating in speed each revolution.

It frequently occurs in turntables of the rim drive type where the track for the rubber inter-wheel is not concentric with the turntable spindle.

The same effect is produced by a turntable spindle that is tight at one point in the revolution or by a scrubbing trip cam which operates the automatic stop system, thus imparting a braking action every time this spot is reached.

UNBALANCED TABLE

A turntable that is not balanced will wear its bearings oversize and the turntable will then run eccentrically, as it will always tilt toward the heavy side as it turns. If an unbalanced turntable is not mounted horizontally, the heavy side will cause the turntable to increase and decrease its speed as the weightier side assists, then retards each revolution.

Gramo motors and governors that "hunt", that is they cannot maintain a constant speed due to excessive wear or "play" in the moving parts, are also a source of wow.

A motor which has excessive end play in its rotor shaft is very prone to hunting, as the play permits the rotor to drift in and out of the influence of the stator's magnetic field, thereby varying the power and speed of the motor. Hunting from this effect is mostly found in motors so mounted that the shaft is horizontal. Motors mounted with the shaft vertical do not hunt so readily, as the weight of the shaft and rotor keep the stator and rotor in more constant alignment.

So much then for wow. "Flutter" is our next concern.

CAUSE OF FLUTTER

"Flutter" is also a rise and fall in pitch caused by variations in the speed of the turntable, but, unlike wow, it occurs at a more rapid rate giving the characteristic "fluttering" or "warbling" sound.

Although it may be caused primarily by inaccuracies in some of the rotating parts, flutter is invariably made apparent when a turntable is too lightly and too flimsily constructed, or when some rotating member is so badly out of balance that it causes the whole turntable unit or pickup to shake at a rapid rate.

Lightweight turntables have insufficient mass and inertia to maintain a constant speed and thus they will readily follow fluctuations in speed imparted to them by the other components.

A good "flywheel effect" is essential in a turntable if flutter is to be avoided and this can only be obtained in a turntable of adequate weight and with this weight correctly distributed. For a good "flywheel effect" the turntable should have most of its mass around its periphery.

The factors which cause fluttering in the first place are: Unbalanced rotating parts; loose bearings around the turntable spindle; flat spots or irregularities in the periphery of the rubber inter-wheel; the rubber inter-wheel being drawn too far in between the turntable and the roller on the motor shaft. [This latter condition has a somewhat "servo effect", and can produce violent and rapid variations in motor load and turntable speed.]

Other causes of flutter are: The hole in the stepped roller on the motor shaft not centrally placed, causing the roller to spin eccentrically (a common cause); the stepped roller of a cast type being slightly oval in shape instead of round, caused presumably by distortion of the metal during casting or cooling; a worn or loose motor governor that is not well balanced will transmit its own flutter through the driving mechanism and a light turntable will follow it.

RUMBLE

The next enemy of "clean" reproduction is rumble.

"Rumble" is a low pitched growling or grating noise which may be fairly constant or may vary in volume over each turntable revolution. It is mainly caused by lack of lubrication, or rough surfaces bearing together, even though these may be well lubricated. Rubber inter-wheels which have hardened are also a source of rumble.

This rubbing or grating of metal upon metal, or other hard surfaces in contact during rotation, generates low frequency vibrations, which, when transmitted through the unit to the stylus tip, result in he pickup delivering their electrical equivalent to the amplifier and speaker. So we hear—rumble.

The next and final nuisance is hum.

"Hum" is often included in the term rumble, but whereas rumble, flutter and wow are mechanical in their origin, hum is not.

It is the result of magnetic pulsations which set the unit into vibration. These pulsations or vibrations are transmitted through the motor board, turntable and record. The pickup in turn again generates their electrical equivalent and so it becomes audible to a distressing degree through the speaker. The offending item in this matter is the motor.

What then causes a motor to vibrate? Alas! many factors, all occurring simultaneously.

The hum that is heard from the speaker when the pickup is lowered onto the record is not the result of any single vibration, but the result of several different modes of vibration occurring in different places inside the motor.

Electric motors, as are well known, consist mainly of "stators and rotors" or "armatures and fields", but there are nonetheless many complex functions in their operation which belie their apparent simplicity.

There are many different types of electric motors each with its own peculiarities, problems and design approach, but we are concerned here only with those types usually employed to drive gramophone turntables.

MOTOR TYPES

They are the "Shaded Pole" induction motor and the "Condenser Start and Run", also known as the "Permanent Split Capacitor Motor". This latter type may be either induction or synchronous.

When the motor is energised from the alternating current supply, pulsating magnetic flux in the air gap between the stator and the rotor sets the frame into vibration.

This air-gap flux wave is far from being a sine wave, for, in addition to the fundamental flux, the current flowing in the rotor and stator produces harmonic fluxes as well.

If the stator is wound so that a number of coils is spaced around it, a distributed winding results. This has the effect of reducing some harmonics but not those known as "tooth harmonics." The effect of these is reduced in turn by "skewing" the rotor bars, so that the bars pass through the rotor diagonally and not parallel to the shaft.

EFFECT OF "SKEWING"

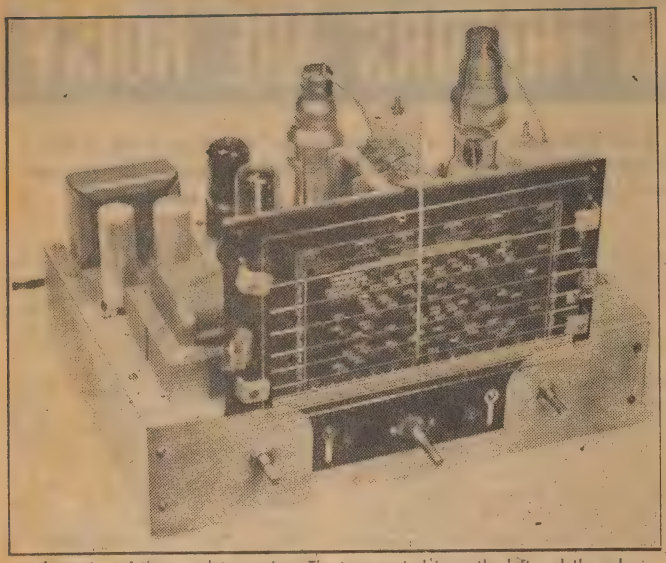
To prevent the rotor bars from having a voltage induced in them by some particular harmonic the rotor bars are "skewed" so that the ends of each bar pass through like harmonic poles.

Unfortunately, this is not a complete cure as more than one harmonic is inevitably present, so "skewing" must necessarily be a compromise.

Skewing the rotor bars is beneficial also in imparting a sliding effect to the bars as they approach and pass the more concentrated poles of a Shaded Pole motor. This reduces the intensity of the shock or impulse that would be apparent if each rotor bar met the air gap flux wave broadside on.

All these vibrations can be reduced but not entirely eliminated.

(Continued on Page 121)



A front view of the complete receiver. The tone control is on the left and the volume control on the right. The converter is just visible behind the dial, IF amplifier on the extreme right, and the audio amplifier rear centre. Note the valve cans and grid leads.

A BASIC 5-VALVE RECEIVER

For a change this month we have temporarily abandoned the modern trend to miniaturise everything—from valves to volume controls—and present a good old-fashioned set with full size everything. Designed to suit a wide variety of valve types it is just the thing to use up those items in the junk box.

by Philip Watson

IN some respects we have a rather guilty feeling that we have perhaps neglected a section of our readers in the recent past, practically all our sets having been described on the basis of the latest components, particularly valves.

While there is no doubt that these appeal to a large section of our readers—particularly those just starting in the game—it is equally true that many readers have a lot of older components on hand, most of them perfectly good and quite useful.

ODD VALVES

It is from these that we frequently receive letters listing an odd assortment of valves and requesting a circuit which will accommodate them. And it is for these readers that we have designed this set.

Some have simply taken stock of the junk box and found that they have most of the major components needed for a full-size set. This being so, they reason that it is just plain silly to leave all the bits and pieces lying idle, when they can be put to good use when built up.

Others have an old-fashioned set which they would like to rebuild, employing as many of the existing parts as possible, but also embodying in it as many modern ideas as they can. In some cases this may involve buying one or even two new valves, plus various minor components, but it can still be a very inexpensive set.

And, in spite of the fact that this is the age of miniature valves, there is absolutely no reason why the older type should not still do a useful job. Admittedly their gain is a little lower in some cases, and the mechanical arrangements are not always quite so convenient, but these are of little consequence to the average home builder.

However, there is one point about the older type valves which we feel we should emphasise. Occasionally we get a letter from a more conservative reader who expresses the opinion that all miniature valves are completely unreliable and announces his intention of using only the older type valves for all his new sets as long as he can still buy them.

Frankly, we can't quite agree with this outlook. If our memory serves us correctly much the same remarks were made about dull emitters when they superseded bright emitters; AC valves when they replaced battery valves; "six pin" types when they took over from "five pin" types; and even the octal types when they were introduced.

MINIATURE "STANDARD"

Doubtless, in a few years, the miniature valve of today will be regarded as the standard of reliability in the face of some "new fangled" type.

The truth of the matter is that the miniature valve is now regarded as standard equipment by all the leading valve and set manufacturers and they are being made and used at the rate of many thousands a week.

Apart from a few early teething troubles and one or two "black sheep" (something by no means peculiar to miniature types) there is no evidence to suggest that they are any less reliable than the types they have replaced.

And, while it is one thing to build a set around the older types when they are already on hand, it is quite another to deliberately purchase these in preference to the current types. Certainly they are still available and are likely to be for quite a while yet, but it must be realised that the main demand for them from now on will be as service replacements.

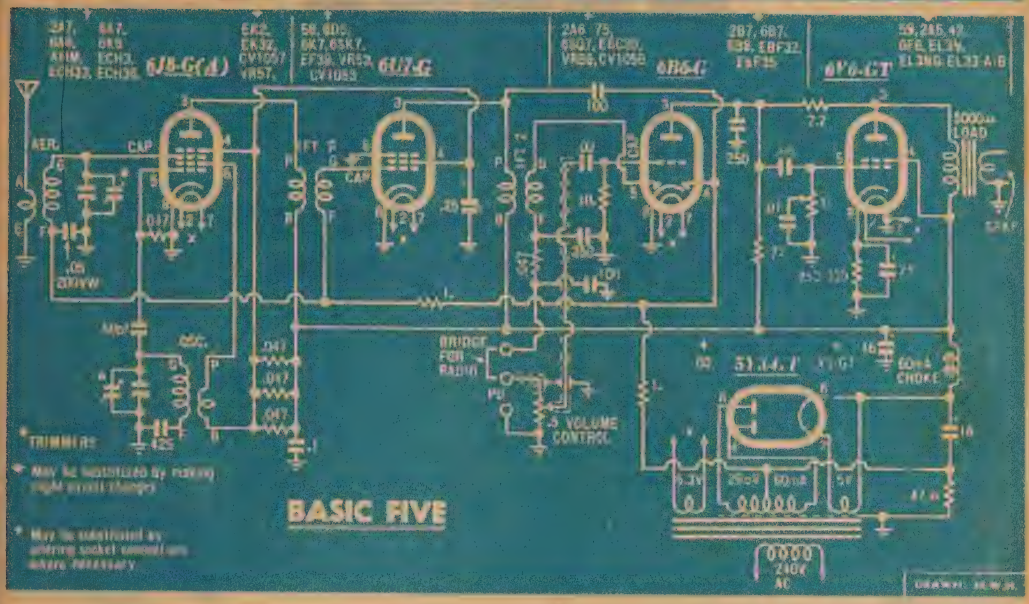
As the demand becomes less and less production runs will become smaller and less frequent, availability will decrease, and the price will increase. One has only to consult the current price of the old 2.5 volt valves to realise this.

Thus, when new valves must be bought, it is well worth while considering the possibility of purchasing the latest types.

Coming to the set proper there are quite a number of points to be considered. The circuit itself is a perfectly straight forward five-valve arrangement of the type which has proved itself time and again to be the first choice of both home-builder and commercial manufacturer alike.

For a project of this kind it is particularly suitable, since it norm-

CIRCUIT SUITS WIDE RANGE OF VALVE TYPES



The circuit is that of a conventional five valve receiver, but employing those features which make it particularly suitable for use with a wide variety of valves. Suggested alternative types are shown.

ally provides a considerable reserve of sensitivity. This means that we have some margin which can be sacrificed, if necessary, in the interests of adapting it to a wide range of valve types.

Bias for the Converter and IF stage is derived from a back-bias resistor in the power supply. In addition to the advantage of cheapness and simplicity which is a feature of this scheme, it has the additional merit, in this case, that the bias will remain substantially constant regardless of the converter and IF valve types used.

COMPROMISE BIAS

By setting this bias to about three volts it will be suitable for almost any type of valve, even though some types can operate on a slightly lower bias. In such cases it will not be possible to realise the maximum gain theoretically possible from the valve, but the loss is negligible in a receiver of this type. All things considered the arrangement represents an excellent compromise of all the factors involved.

The screen and oscillator plate supply is similarly designed to deliver approximately the same voltage over a wide selection of valve combinations. It is simply a series dropping resistor from the HT line and should deliver between 90 and 100 volts under no-signal conditions. Since three separate elements are supplied from this source a variation in characteristic of any one would not have a significant effect on the voltage.

Bias for the audio amplifier stage is derived from a 10 megohm grid resistor and has the advantage of functioning virtually automatically over a wide range of valve types. In general this scheme is satisfactory for pentodes and high-mu triodes. It is less successful with low-mu triodes and this rules out the use of pentodes wired as triodes, unless a cathode bias network is provided.

For the output stage we have specified a cathode-bias system. The main reason for this is the fairly wide variety of bias values required for different output valves, varying from 16.5 volts for the older types to six volts for the later ones. This is most easily taken care of when the bias network is independent of any other part of the circuit.

The only other characteristic effecting the output stage is the load into which it is to work. This will be either 5000 or 7000 ohms and simply implies the selection of a suitable speaker transformer.

However, the value is not as critical as is popularly imagined and either value would suit most valves quite well. This is particularly so when a negative feedback circuit is employed and it is doubtful whether the purchase of a new transformer would be justified.

PARTS LIST

1 Chassis 13in x 9in x 3in (Simplified B/C Receiver July 1950).
1 Power transformer 285 volt 60 or 80 ma. 6.3V 2A. 5V 2A.
1 60 or 80 ma 30H choke.
1 Dial B/C glass suit gang (USL32 or similar).
1 Speaker, permag type, size as required. Transformer to suit output valve.
1 B/C Aerial Coil.
1 B/C Oscillator coil.
2 455 Kc IF transformer Nos. 1 & 2.

VALVES

1 6J8G, 1 6U7G, 1 6B6G, 1 6V6GT, 1 5Y3GT, or alternative types. See text.

RESISTORS

1 10 meg, ½W, 1 2.2 meg. 1W 1 1 meg. pot, 2 1 meg. ½W, 1 .5 meg pot., 1 .22 meg 1W, 3 .047 meg. 1W, 2 .047 meg. ½W 1 250 or 300 ohm 1 or 3W (See text). 1 47 ohm 1W.

CAPACITORS

1 25 mfd 40V electrolytic, 2 16 mfd. 350V electrolytics (one insulated type). 1 .25 mfd 400V paper, 1 .1 mfd 400V paper, 1 .05 mfd 400V paper, 1 .05 mfd 200V paper, 1 .02 mfd 400V paper, 1 .01 mfd 200V paper, 1 425 pf mica, 1 2 gang tuning capacitor, 2 250 pf mica, 1 100 pf mica, 1 50 pf mica 2 trimmers.

SUNDRIES

5 Octal sockets or as required for valves, 3 valve shields or as required. 1 4 pin socket (standard size). 1 4 pin plug to match, 2 red terminals 2 black terminals, 1 green terminal, 3 grid clips, 1 5 tag terminal strip, 2 3 tag terminal strips 3 knobs, 1 8 tag terminal strip, shielded hookup wire, plain hookup wire, solder lugs, nuts & bolts.

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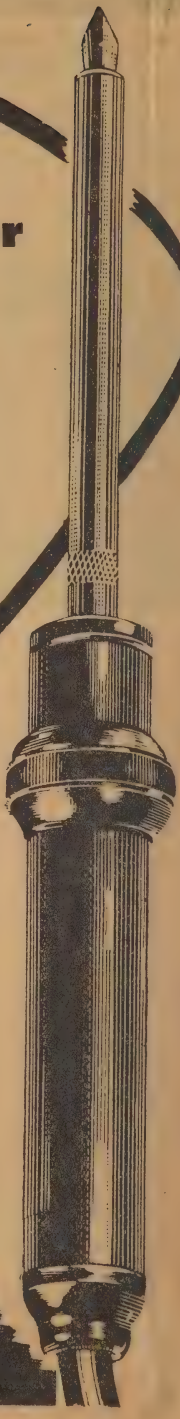

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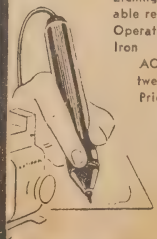

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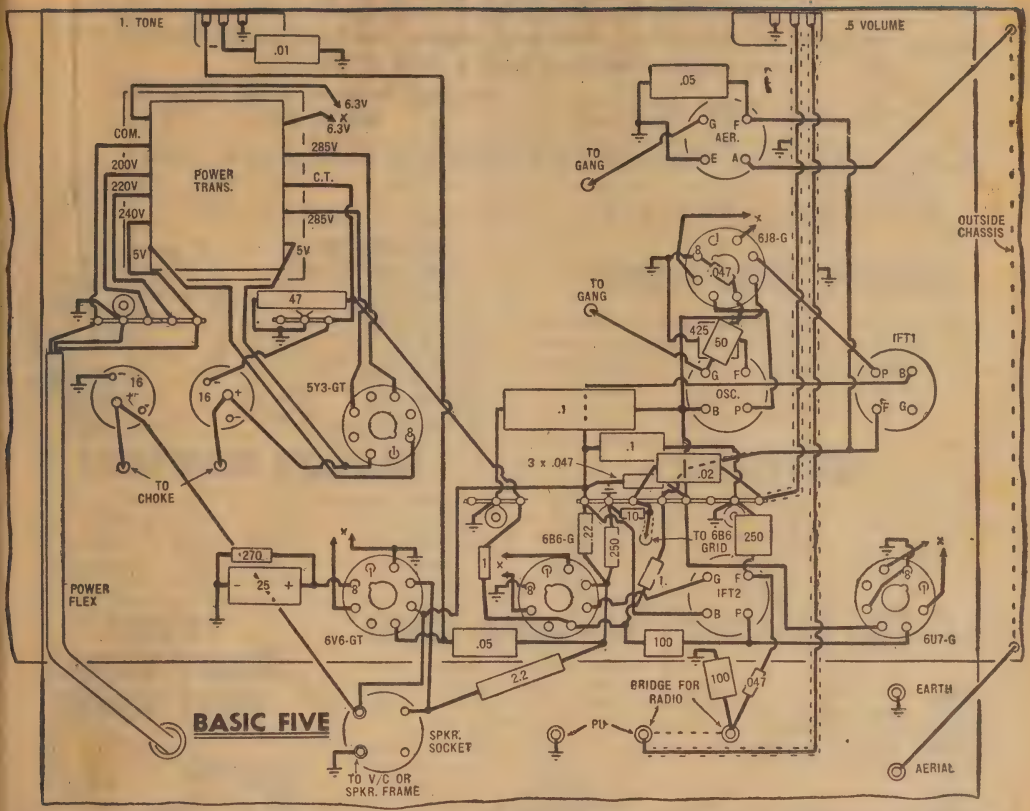
WIRING DIAGRAM SHOULD HELP THE BEGINNER



Used in conjunction with the circuit diagram this should enable even a beginner to get things correctly laid out. Note, however, that other valve socket orientations may be necessary for other valve types. Short grid and plate leads should be the main consideration.

The valves we used in the original set are those which we considered most likely, by reason of their popularity in the past, to be found in the average builder's junk box. We have listed alternative types on the circuit, dividing them, where necessary, into two groups.

One is of those valves which can be substituted by simply altering the socket or socket connections. The other covers those types requiring slight alterations to the circuit. These alterations are shown in the group of auxiliary circuits.

For the converter we chose a 6J8, but there are several we can use in place of it. In the 2.5 volt series there is the 2A7 and the 6.3 volt version is the 6A7. The octal version is the 6A8 and these should all work equally well on the broadcast band, even though they have limitations on the short-wave bands.

The 6J8 is better in this respect, being a good all-round performer. The 6K8 is of comparable merit, while the X61M is a comparatively modern valve with a high order of performance.

In the European series we have the ECH3, ECH33, and ECH35. The first two are electrically identical, while the ECH35 differs only in one or two minor points.

All these valves may be used in this circuit without any changes other than those of socket and pin connections.

The only valve of this group which we suspected might call for circuit changes was the 6K8. This has a very high gm triode for the oscillator section and we considered there might be a risk of squegging and similar problems when used with the same oscillator coils as the for the 6J8, &c. However, a practical test soon dispelled any qualms and it appears to work quite as well as the other types.

OTHER SUGGESTIONS

Four other types which may be encountered are the EK2, EK32, and their service equivalents the VR57 and CV1057. For all practical purposes these four may be regarded as electrically identical. The main difference between these and the first group is that they require only 50 volts screen supply.

The circuit alterations necessary for these is shown in the auxiliary circuit. It consists of adding a .068 meg resistor in series with the screen supply and providing an extra bypass.

Incidentally, the two service types we mentioned have been readily available through disposals, sometimes for only a couple of shillings each. They represent a very good buy for a project such as this.

For the IF amplifier we chose the 6U7 as being a typical type, but any of the other suggestions could be used without the need for anything but mechanical changes. (Sockets, pin connections, &c.).

The 58 is the 2.5 volt version, but all the remainder require 6.3 volts. Although they represent a wide range of types with differing orders of gm, they will all work quite happily with 100 volts on the screen and three volts on the grid. Once again we list a couple of service types, which have been readily available.

Coming to the detector and audio amplifier we have the choice of either a pentode or a high-mu triode, both with a pair of diodes for detection and AVC. We chose the 6B6, a high-mu triode, main-

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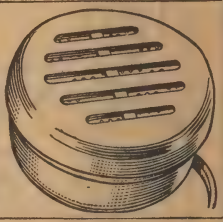

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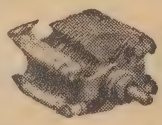

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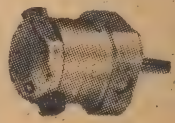

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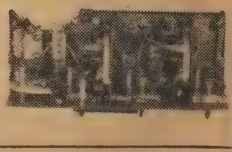

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ly because it was about the most popular of this type and the triode arrangement is slightly the simpler.

The 2A6 is the 2.5 volt version and the 75 its 6.3 volt equivalent. The 6SQ7 is a fairly modern version and the EBC33 the European type. Together with the service types VR55 and CV1055 they will all perform quite satisfactorily with a 10 meg grid resistor and a .22 meg plate load.

To use a pentode it will be necessary to add a screen dropping resistor and screen by-pass capacitor. Although the respective resistance-coupled charts may show slightly different values for some types, the suggested 1.5 meg. should be close enough for all practical purposes. Of the types suggested the 2B7 is the 2.5 volt type, the 6B7 the early 6.3 volts equivalent, the 6B8 the octal version, and the EBF32 and EBF35 the European equivalents.

OUTPUT STAGE

For the output stage our choice of the 6V6 was almost automatic, since this must surely be one of the most popular output valves ever made. In its class it must almost rival the famous 80.

But if your junk box goes back further there are plenty of older types which may be used. The old 59 when connected as a pentode (grid 3 tied to cathode) is electrically similar to the 2A5 when operated from a 250 volt HT line. Both these are 2.5 volt types, the 42 is the early 6.3 volt version, and the 6F6 the octal equivalent. They all call for a bias resistor of between 450 and 500 ohms and an output load of 7000 ohms.

In the European series the EL3N was a popular choice, by reason of its high sensitivity. This type used a "P" base, but was quickly replaced by an octal based version known as the EL3NG. Later both types were replaced by the EL33, EL33A, and EL33B. All are equivalent electrically, but the last named have minor differences in the provision of an outer sprayed metal shield and its earthing arrangements.

They all require a bias resistor of between 150 and 180 ohms and a plate load of 7000 ohms. Because of their high sensitivity these valves were prone to supersonic oscillation unless suitable precautions were taken. In most cases it was sufficient to fit a grid stopper of anything between 4700 ohms and .047 meg. This can be a half-watt type and should be connected right at the grid pin.

SCREEN STOPPER

In stubborn cases it is also helpful to fit a screen stopper of 100 ohms. This should also be connected right at the socket pin and may be a one-watt type resistor.

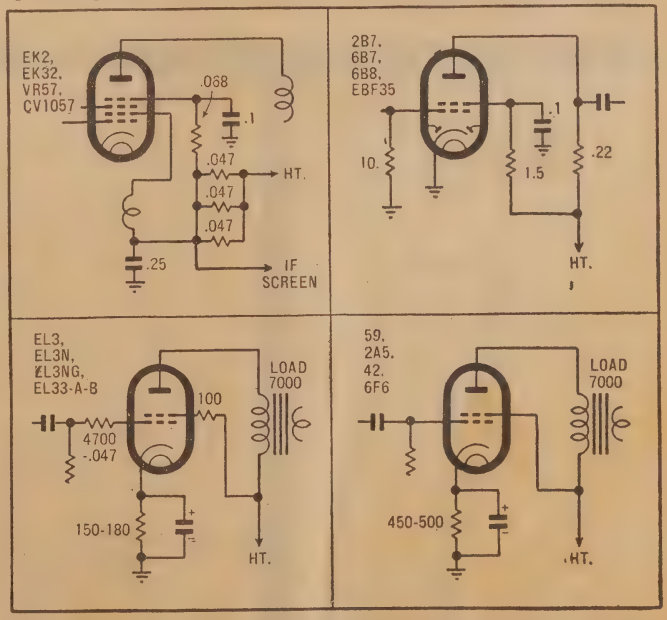
It will be noted that we have quoted alternative values for the bias resistor for these valves. The lower value is hat recommended by the maker and may be used if the power transformer is large enough to supply the necessary current. (Say an 80 mA type or larger.) The larger value has been selected on the basis of a 60 mA power supply, and reduces the current by slightly over-biasing the valve.

This reduces the available power output slightly, but there will still be more than can be let loose in an ordinary lounge room. In these circumstances there is no point in scrapping a perfectly good 60 mA transformer and wasting money on a larger one, simply to provide for a possible power output which will never be used.

In place of the 5Y3 which we chose can be substituted an 80, of which there are probably thousands tucked away in innumerable junk boxes throughout the country. A more modern type which could be

MAJOR COMPONENT POSITIONS

All the major components are clearly shown in this picture. The IF amplifier is on the left, the audio stage in the centre front, and the output stage on the right of it. The first IF transformer is just visible behind the IF amplifier.



These circuits show circuit changes required to accommodate some of the suggested alternative valves. Note the stoppers in the EL3 &c circuits, which should be fitted as a matter of course.

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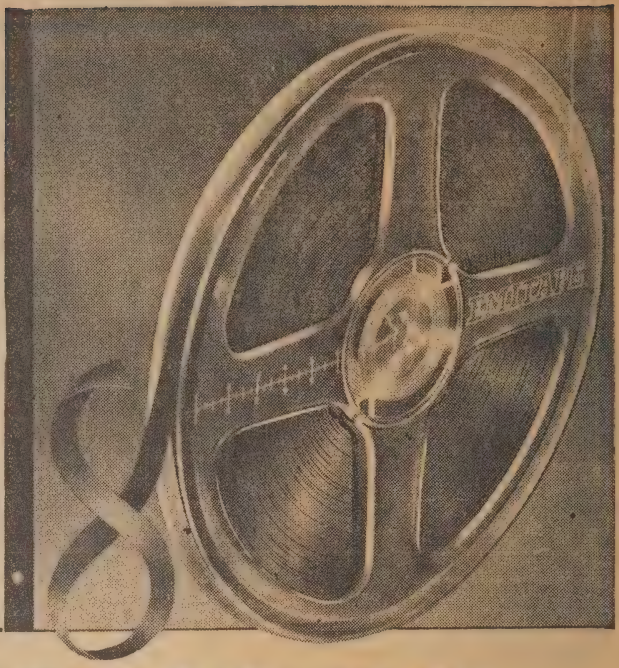

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used if it happens to be available is the 6X5. This will deliver a few more volts of HT but hardly sufficient to call for a dropping resistor.

Since it has a 6.3 volt filament and an indirectly heated cathode it may be connected to the same filament winding as the rest of the valves or a second 6.3 volt winding if there is one. When only one winding is available, make sure it is large enough to carry the extra current. In most cases this should be so.

Next point to be considered is the mechanical arrangements for the various valves. Since we are assuming the valves are on hand the selection of suitable sockets should not present any problem. However, identification of the base pins is another matter.

TOO MUCH

Quite obviously data for all the suggested valves cannot be included in the circuit and the logical approach is to refer to valve data books published by the various valve maufacturers.

To cover the older valve types we suggest the Philips Valve Data Book and the RCA Receiving Tube Manual. To cover those purely Australian types the Radiotron Valve Data Book or one of the simpler booklets published by the same firm will be quite satisfactory.

American and Australian type valves will invariably require external metal shields on all except the power valve and rectifier. It is more than likely that these will also be on hand with the valves, but if not they will have to be purchased. The bases should be mounted at the same time as the valve sockets.

In the case of the form-fitting variety there is the choice of a chassis mounting earth clip or a cathode clip which slips over the valve spigot and connects the shield to either pin one or pin eight. Obviously these latter are only suitable for octal sockets.

Most European type valves are already shielded, this taking the form of a metallic paint sprayed over the glass envelope. It is normally connected to one of the base pins which should be earthed.

COIL MODIFICATION

Because most of the older type valves have the grid connection at the top it may be necessary to modify the first IF transformer and the aerial coil to provide a grid lead from the top of the can. Older coils may already have these but they are seldom fitted to the modern types.

Slip the coil out of the can and identify the grid pin. Solder a short length of hookup wire to the inner end of this pin, pass it through the hole in the top of the can, then reassemble the coil in the can. Naturally the coil should be handled with care while out of the can to avoid any chance of damaging the relatively fine wires.

Although we have laid most emphasis on the variety of valves which can be used there are a number of other components which may be salvaged from the junk box. As already mentioned, it is possible to use a 60 mA power transformer by using the higher value of bias resistor for the output valve. The same remarks apply to the rating of the power choke.

Although a 285 volt type is specified it would be possible to use one of the older 385 volt types in conjunction with a dropping resistor. You may get away with the scheme of using this in place of a choke if you are not particularly fussy about hum level, but a better method is to connect it in series with the choke. For this arrangement a value of 1500 ohms will suit a 60 mA drain and about 1200 ohms for an 80 mA drain. The wattage rating should be at least 10, and preferably 20. Mount it above the chassis to allow the heat to radiate.

An even better position for the dropping resistor is between the transformer centre tap and the first electrolytic. In this position less resistance will be required to produce the same voltage drop, peak currents through the electrolytic, the rectifier, and the transformer will be less, and less heat will be generated in the dropping resistor. The only snag is that it is difficult to calculate the exact value of resistance required, but it should be approximately half the values suggested above.

WATCH THE VOLTAGE

It is most important that a 600 volt electrolytic should be used in the first position and preferably in the second position also when a 385 volt transformer is used.

The gang may be almost any type for which a matching dial can be found and this rules out some of the very old timers. The only way of using one of these would be by using a 0-100 dial with provision for hand lettering the local call signs. Watch the available chassis space if one of these older gangs is contemplated.

It is also possible that an odd IF transformer, aerial or oscillator coil may be available. If so there is no reason why it should not be mixed with such new ones as are needed. However, the very old types, made before the days of iron cores, are hardly a proposition. In particular, IF transformers with compression type trimmer adjustments can give a lot of trouble.

Some aerial and oscillator coils were made with fixed iron cores, an arrangement which made the coil quite efficient but lacked the advantage of adjustable inductance of the later types. These can be used provided an adjustable padder is used in place of the fixed type, and tracking problems should not be serious provided the gang and dial are matched.

ALIGNMENT

This naturally raises the question of the alignment procedure to be used for various padder arrangements, &c. Since the complete story is too long to relate here, we will simply remind readers that we have available a very comprehensive pamphlet covering the subect and which is available through our query service for 1/-.

The speaker should be a permag. variety, preferably with the correct type speaker transformer. One of the older electro-magnetic types could be used if it is available, but would call for a 385-volt power transformer. A 1500-ohm field was a very popular value and would be quite suitable. It would be wired into the circuit in place of the filter choke.

Other field values which were used, though less often, were 2000 and 2500 ohms. Either value could be used though, naturally, at the expense of reduced HT voltage.

However, before deciding to use such a speaker, consider carefully its present condition. If it is anything less than 100 pc it may not be a proposition to design the set around it, particularly as many of these older speakers can no longer be repaired by the makers.

Constructionally there are not many points which require explanation. The chassis is that originally designed for the Simplified Broadcast Receiver of July, 1950. This should be readily available from your dealer, and its use greatly simplifies the layout and assembly.

However, a point to watch is the orientation of the valve sockets when other than the original valves are used. In some cases the differences will be slight and of little consequence; in others they can be quite serious. You will have to use your discretion in this matter and orientate the sockets to suit the particular valve. In some cases this may mean drilling alternative mounting holes.

The two critical leads in all such cases are the grid and plate leads. These carry RF or IF and should be kept as short as possible. The HT and AVC leads on the other hand, are by-passed to the chassis and carry only DC. For this reason their placement and length is not critical.

The one exception to this is the connection between the AVC diode and the one-meg. AVC load resistor. The diode end of this resistor is "hot" and should be kept as short as possible. The other end of the resistor is by-passed and is not critical.

EARTH VOICE COIL

We found it beneficial to earth the voice coil or frame of the speaker and this can be quite easily provided by means of a third wire and speaker plug pin. This is mainly a precautionary measure, but is a good thing in principle, since it minimises any chance of oscillation due to small amounts of RF in the speaker circuit and which may couple to the aerial.

The type of power transformer used will govern the arrangements for wiring to it. Some of the older horizontal types were fitted with terminal boards, whereas the more modern type have loose leads. In the latter case most of the wires may be wired directly to their appropriate terminals on various components. The exception is the primary connections, which will need a tag strip for their termination as well as the actual mains leads.

Details of the placement of the minor components will be found in the wiring diagram and under chassis photograph. These, together with the circuit, should provide all the information needed to complete the job.

Regardless of the valve combinations you use you should have no difficulty in making a first-class receiver, even the oldest valves, if they are in good condition, being capable of providing an impressive sensitiviy in a set of this kind.

So there it is. Haul out the junk box, take stock of what you have, and you may possibly build a first-class set for next to nothing.

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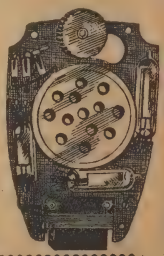

Note. A Miniature Loudspeaker may be operated (at low volume levels) from either of the above circuits; for this we recommend a 45V H.T. Supply. The Crystal Microphone is, of course, not required for the above circuits.

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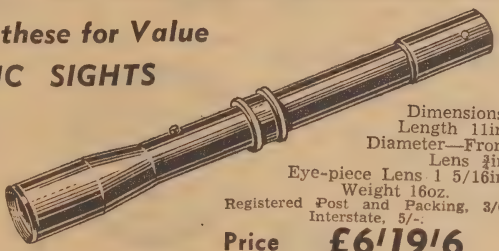

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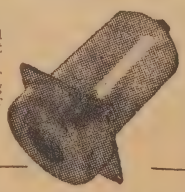

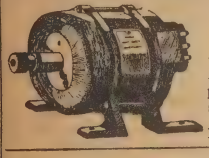

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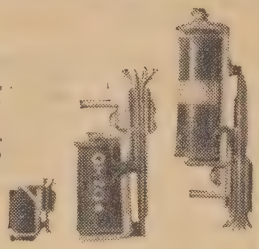

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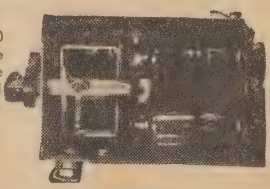

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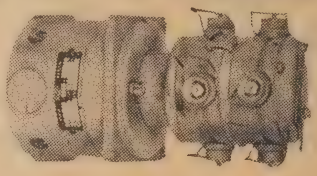

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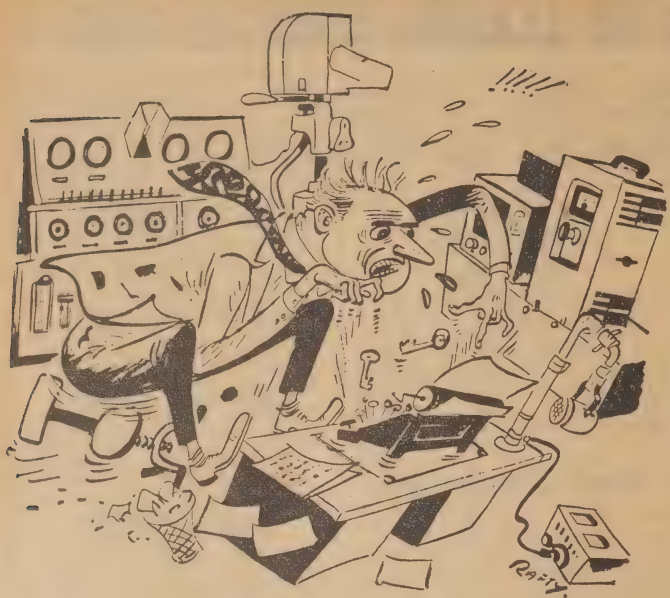


Let's Buy An Argument

If one wants to start a spirited argument, the subject of electric organs is as good a one to pick on as any I know. Some regard them with a fervent hatred; others dream of the day when they'll be able to put aside other distractions and build one of their very own!

by Neville Williams

RIGHT now, the interest in electric organs seems to have reached another peak. The first one occurred some years ago, after the local release of the "new-fangled" Hammond. Dozens of people seemed to be rushing around with gear blanks, looking for somewhere to have them cut.

I know. I was one of them!

NEVER FINISHED

Then the war intervened and very few of the proposed organs were ever built. Mine certainly wasn't, though I still have a lingering ambition.

After the war, there was a minor resurgence of interest, this time with the emphasis on electrifying a basic reed action.

One man I know spent a good deal of his spare time collecting discarded reed organs at an average price of about £2 each. He still has about four of them, hopefully stored in the rafters of his garage!

But reeds have obvious limitations and right now, the interest is greatest in purely electronic organs —those using oscillatory circuits to generate the initial signals.

Recent articles in this journal by R. A. B. Tarrant have brought the interest to a head and also called forth some criticism from one or two folk who aren't entirely in accord with his summation of the position.

One such critic is Mr. J. E. Jung, of Eastwood, NSW. Mr. Jung puts his point of view quite ably and it hardly needs amplifying—but it is a particular point of view stemming, I would say, from the "purist" approach.

I can see deep water ahead but why hesitate? "Fools rush in . . .&c".

To the absolute "purist" (if qualification is necessary) an ORGAN i wholly and solely an acoustical in strument, based on the use of pipe and built in accordance with cer tain recognised practices. It is pre sumed to be installed in an appro priate building with appropriate in tent.

Departures from this rather sac red code are deplored by the sai purists, the whole concept of "cinema organ" being automaticall beyond the pale—by design, by loca tion and by intent as well!

ON THEIR MERITS

Having no such strong convictior myself, I'm quite prepared to liste to such (ahem!) organs on thei merits and according to the wa they're played.

I must say that, quite apart fron their "jingle-bell" propensities, I'v heard far more pleasant ecclesiasti cal music emanate from them tha from some of the conventiona "organs" that repose in our subur ban churches. And I'm not referrin to reed organs either!

However, enough of that.

To the aforesaid absolute purist the term "electronic organ" is abou as consistent and compatible a "Home-made Meat Pies", offered over a chain store counter!

You just can't have an organ with out pipes.

But more practical, more earthy souls admit the impossibility of eve owning a pipe organ or installing on in their homes. They reason tha they should be able to produce th same kind of sound electronically— if they try hard enough.

Their objective is crystal clear— to produce sounds which duplicat those one expects to hear from conventional pipe organ. Further t have those sounds controlled fror a console of conventional design an with stops tabs bearing conven tional names.

WORTHY OBJECTIVE?

Who am I to say that this is not worthy objective? It is obviousl the one being sponsored by our cor respondent, Mr. Jung.

While I can't vouch for his cata loguing of organ types, the point h makes about separate oscillators a perfectly legitimate one. Only b having separate oscillators, he claim can one begin to duplicate the "ran dom" pitch and phase of an acoust organ.

And how random it is.

Every single pipe has to be indi-vidually tuned and is therefore sub-ect to individual error. Part of this s attributable to the weakness of he flesh, part to a possible deliberate nistuning to compensate for incon-istency of "voicing" in the pipes.

When the organ is finally played he sounds emanate from various egions in the organ structure and re subject to different and random eflection effects in the building. The listener hears the sum total — notes, errors, beats, echoes — all at nce. Hence the "weight", the com-plexity, the non-directiveness of ound from a large organ.

The building too, has an essential ole in determining the sound qual-ty.

For all that, some professional uilders claim to have achieved com-plete "realism" from electronic cir-uits; so much so that they will defy isteners in a cathedral to tell the ifference from the "real thing".

ACOUSTICS

But they go to a lot of trouble to chieve this result. They make full se of the building's acoustics, they se multiple speaker systems and ven arrange for the speakers to be pun around on rotating panels to reak up standing echoes.

Maybe that's all very well in a hurch, but just imagine trying to alk one's spouse into allowing such goings-on in the domestic lounge-oom! No, sir.

Acoustic limitations just about ave one beaten from the start.

But, for all that, the urge to create rue "organ" music in such a situa-ion is a strong one, which continu-ally spurs on new generations of nthusiasts. Perhaps the multiple enerators suggested by Mr. Jung rovide an essential starting-point for uch a project. Perhaps they don't.

I imagine that there are folk who re quite ready to take up the udgels on behalf of basic designs vhich Mr. J. doesn't seem to like.

And all this brings me surely to n inevitable but very pertinent ques-ion: Is there any moral reason why n electronic organ must duplicate ompletely and only the sound qual-ty of its traditional acoustical coun-erpart?

Are not these instruments, in any ase, nearing obsolescence? I'm too ar away from the whole subject to now any figures but I imagine that he production curve of pipe organs nust be well past its peak.

ON THE INCREASE

Conversely, I should expect to see hat the production of electronic rgans is on the increase, not only o replace the time-honored har-nonium in small churches but to e installed in large churches where therwise, a large and expensive pipe rgan would be employed.

I have before me, as I write, an rticle in "Electronics" describing n electronic organ installation which ecently replaced an unserviceable ipe organ in a large American hurch. Here are a few of the salient oints:

The organ has a 3-manual and

DESIGN OF ELECTRONIC ORGANS

Dear Sir:

The recent series of articles on the electronic organ in Radio, TV and Hobbies is creating a widespread interest in this subject; it is important therefore that no wrong impressions be given to your readers.

It seems to me that the idea has been fostered by the author of these articles that the type of organ employing frequency division is superior to the types using separate independent L/C oscillators for each note.

In the September issue a number of makes of electronic organs is listed, and it is then stated that "Allen, Constant Martin, and Connsonata organs use individual tubes for each note, the remaining makers resorting to frequency division".

I cannot let this impression go unchallenged, as it is contrary to the facts. There are at least 11 manufacturers of electronic organs to my knowledge in USA, and of these only Baldwin, Minshall and Lowrey Organo use frequency division.

The Thomas organ also does so, but is in an entirely different class, as it uses an additional tube for each note on each manual and pedal division for electronic keying.

The reason why the majority of builders prefer not to use frequency division is easy to see —firstly, as these tubes are in continuous oscillation all the time the organ is switched on, it is extremely difficult to control the envelope, i.e., the attack and decay in the speech of the tones when keyed, and secondly, as the dividers are locked together in octaves of mathematical exactness, and in exact phase relationship, it is quite impossible to produce the ensemble or chorus effect which is characteristic of all organ music when played in several pitches simultaneously.

No matter how closely an electronic instrument approaches the pipe organ in other respects, it will fail to interest, and may even irritate an organ enthusiast if it lacks envelope control and ensemble.

The generator using independent L/C oscillators, which has now been adopted by the majority of manufacturers, lends itself to easy attainment of both these desirable features in an electronic organ.

As the tubes oscillate only when keyed, it is merely a matter of choosing the correct time constant for the R.C network feeding the B+ to the anode via the key switches in order to produce any desired attack and decay, and thus the effect of pipe speech is exactly duplicated.

Furthermore, as each oscillator in the whole generator functions independently from all others, and are individually hand tuned similar to a rank of pipes there are slight deviations from exact tuning, and of course there is no phase relationship, and this is what creates what we call ensemble, and is characteristic of every pipe organ.

It is something which no system employing frequency division in locked octave and phase relationship can reproduce.

Finally, frequency division, in order to function correctly must generate a sharply peaked pulse waveform in which the upper harmonics predominate and which includes very little fundamental; yet most tone colors require a strong fundamental. Particularly does this apply to the flute and diapason families, and this makes it very difficult to regulate or voice these tones evenly over the whole compass of the keyboard.

The L/C oscillators on the other hand can be circuited to give any desired waveform ranging from sinusoidal to pulses, and thus the waveform best suited for tone formation is selected.

In one model, the Connsonata Organ, two entirely separate outputs are taken from each oscillator, one giving a waveform of substantially sinusoidal shape which is used for the fundamental and the other output is a pulsed waveform which provides all the necessary harmonics.

It is by mixing these two outputs in the precise proportions to give the desired tones, which moreover can be preserved in balance from top to bottom of the keyboard, that this particular electronic organ more closely resembles the pipe organ than all others.

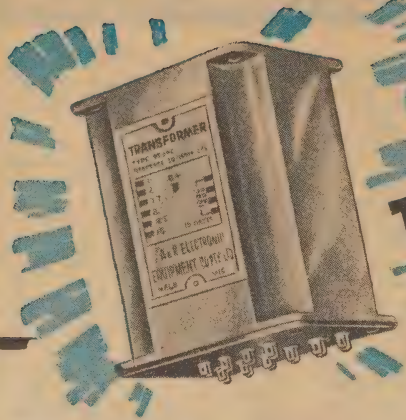
Of those organs mentioned as using frequency division in the September article, only the Baldwin makes any attempt to control its attack and decay, this through the complicated gradual resistance key switches, as described in an earlier article.

The other two, Minshall and Lowrey Organs, make no attempt at control and the voices speak with an abruptness even more pronounced than the Hammond, and despite key click filters used by Minshall, the clicks are still there.

The Organo is definitely the most unorganlike of the whole lot.

Regarding home building, no doubt, as pointed out in the September article, an instrument using either the Minshall or Lowrey circuits could be built in the home more easily and cheaply than any of the other types, but just whether an organ enthusiast would be very happy with the tonal results is quite another matter—perhaps not as happy as a High-fi fan would be with a mantel set.

Yours faithfully,
(JOHN E. JUNG)



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Sec.: 2 or 8 ohms.

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TYPE 931-8: 20 watts.
Prim.: as 931-15.
Sec.: 2 or 8 ohms.
Resp.: As 931-15.
Valves: As 931-15.
19% Screen Taps.

TYPE 921-15: 20 watts.
Prim.: 6600 ohms P.P.
Sec.: 3.7 or 15 ohms.
Resp.. 10-60,000 cps.
Valves: 807, KT66, etc.
19% Screen Taps.

TYPE 921-8: 20 watts.
Prim.: As for 921-15.
Sec.: 2 or 8 ohms.
Resp.: As 921-15.
Valves: As for 921-15.
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TYPE 916-15: 12 watts.
Prim.. 8500 ohms P.P.
Sec.: 3.7 or 15 ohms.
Resp.: 10-50,000 cps.
Valves: 6BW6, 6V6, KT61, etc.
19% Screen Taps.

TYPE 916-8: 12 watts.
Prim.: As 916-15. Sec.: 2 or 8 ohms. Resp.: As 916-15.
Valves: As 916-15.
19% Screen Taps.

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pedal console, following standard organ practice.

The Great Organ employs 84 valves as tone generators, 4 as pre-amplifiers and 252 copper oxide rectifier elements in wave shaping circuits.

The Swell Organ, Choir Organ and Pedal Organ are only slightly less ambitious in their design, each having its own separate tone generating system.

SEPARATE SECTIONS

Each organ section has its own power amplifier and speaker system involving, in all, 12 preliminary valves, 24 6L6 beam tetrodes, 4 voltage regulators, and 15 power rectifiers, including a couple of 866's.

Spatial coverage is obtained by mounting the speakers relevant to each organ section behind the grilles which formerly covered the pipes and in approximately the same positions which the pipes originally occupied. Each speaker set involves woofers, middle speakers ("Squawkers" I believe) and tweeters.

To simulate the characteristic pitch-fringing effect of a pipe organ, the middle and high frequency speakers are mounted on rotating baffles, whose speed can be controlled from the console.

Increasing the speed of rotation sufficiently gives an excellent tremulant effect.

The oscillators and waveform shapers for each organ section are preadjusted to give four basic tone qualities . . . reed, string, diapason and flute.

These are further subdivided to provide the equivalent of eight sections of pipes . . . Vox Humana, Trumpet, Aeoline, Viole, Flute, Flute Dolce, Diapason, Dulciana.

To a traditional organist, the whole thing must look very modern, yet very homely.

How does it sound? I haven't the faintest idea, except that a system using presumably 216 basic oscillators, subdividing into 1728 basic tone colors and radiating on a broad front through 4 entirely separate rotating speaker systems — all of it into a lofty church building.

Well, it should be able to produce a fair kind of ensemble effect!

"But so it should", you might say; "a thing as complex as that."

To be sure it is complex but I doubt whether it would be anything like as complex or as costly as a pipe organ with comparable specifications.

It could presumably be built and adjusted in the factory, then set up in a church with a minimum of installation worry. At least its very soul wouldn't have to be "tailored" to fit the nooks and crannies of each individual building.

MAINTENANCE

Once in place, I doubt whether the thing would need anything like the same maintenance that is required to keep a pipe organ in trim. It's rather staggering to realise that a pipe organ has to be (or should be) checked and tuned every week, to keep up with natural deterioration and tuning drift due to atmospheric variations; to realise that this costs big churches, halls and theatres anything from three to eight guineas a week (to quote figures I have recently heard).

No wonder that managers, councillors, deacons, elders—or whoever have the say in the matter—are receptive to propositions about organs with "pipe quality" but costing less to maintain and instal.

Against all this, one might voice the objection that such mass-produced instruments might achieve a flashy uniformity but lack the charm and the variation of old organs built into old churches by old craftsmen.

That such a "charm" exists cannot be denied, but is it associated with an excellence of musical quality or just "ye olde and anciente crafte?

Period cars have a "charm" for many people, but most of them would still prefer to travel in a modern mass-produced Ford!

However, I didn't altogether mean to get mixed up in an argument about organs old and new. I like big pipe organs, I like crawling around old ones—but I'm likewise tolerant of the unitised "cinema" types and I'm very interested in the electronic variety as well.

Getting back to the big electronic "Allen" organ that I referred to earlier, the writer makes the point that the "attack" and "decay" has been controlled so that the notes speak naturally in the manner of pipes.

However, this is achieved purely by time delay in an electrical circuit and it is quite easy to speed up the attack or to exaggerate the decay.

The tremulant can likewise be varied easily by an electrical control and other effects added by further modifying the output from the tone generators. Percussion effects including the harp, harpsichord, harp celeste and glockenspiel are readily attainable.

All this "results in an instrument with musical potential beyond that of a pipe organ".

I can imagine that the purist will object to this quoted statement wholeheartedly and forthwith. It might be regarded as musical high-treason to suggest that the potential of a pipe organ should be extended—or should need to be extended.

WHAT POSSIBLE REASON?

If the attack and decay on a conventional organ is not variable, what possible excuse can there be for providing variable qualities in its electronic counterpart?

Perhaps there were two reasons why variable attack has not been included in traditional organs: (1) Organ builders didn't consider the facility appropriate and (2) They had no means of providing it.

I leave it to you to judge which reason was the more potent one.

There seems little doubt that the builders of many large organs were the victims of "attack" rather than the masters. I understand that careful analysis has been made recently of the way various organs respond to the playing of some of the faster organ classics.

Despite industrious drawing of stops in the console, some of the slower-speaking pipes either lagged hopelessly behind their felows or failed to speak at all!

Perhaps one can sum up the whole position something like this:

1. Pipe organs and the music therefrom is steeped in tradition, which dies hard anyhow.

2. Modern electronic instruments can offer "organ-like" music at much lower over-all cost. However, designers are hard put to it to duplicate the "massiveness" and peculiar sound qualities of the acoustic instrument.

3. A swing to electronic organs, based mainly on economics, may increase their public acceptance and ultimately downgrade the importance of traditional instruments as a standard of reference.

4. The greater versatility of electronic generators may ultimately outdate acoustic generators, even as electrically controlled consoles have outdated the ancient pneumatic systems of pipe control.

5. Anybody got an old pipe organ they don't want after reading the above? Address your letters to the Technical Editor . . . &c.

And what of the homebuilder? Here we come right back to the apparent difference of opinion between Messrs. Tarrant and Jung. Must the homebuilder use separate oscillators, multiple manuals, multiple amplifiers, speakers and so on?

He can if he wants to, but I can foresee practical and economic difficulties in the way. In fact I can see difficulties in the way of his making any kind of an organ at all.

At best he may have to settle for something pretty simple. It may not sound a bit like the one in the Sydney Town Hall, but of one thing I am certain . . . It will sound a lot better than the harmonium or the (ahem) American organ, which he has at present.

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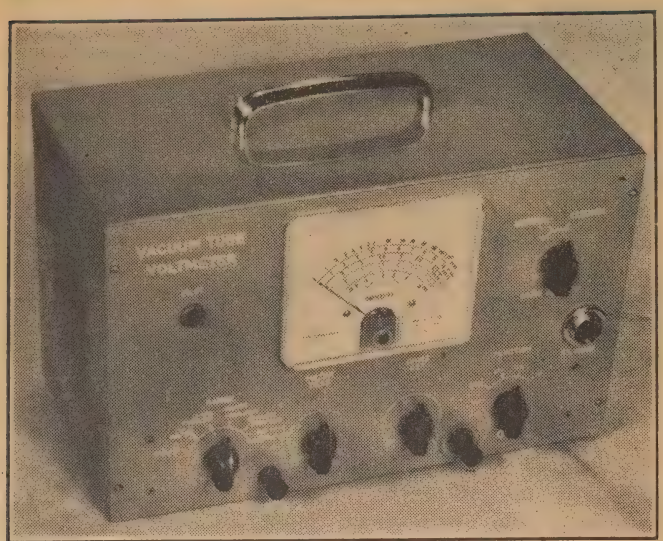

A photograph of the finished meter. A special meter scale is being made available by the meter manufacturers. Note that all measurements are made using only two test points.

DESIGN OF VT VOLTMETERS

As announced last month, we are planning to describe in these columns a new Vacuum Tube Voltmeter, which will be a worthy companion-instrument to our Audio Generator. But what is a V.T. Voltmeter? Why is it used? What are the salient design problems? These and other questions are answered for you in this preliminary article.

by Reg. Rawlings

MOST resistance and voltage measurements in the laboratory and service shop are made with a conventional multimeter, because it is fully portable, simple to use and accurate enough for most purposes.

However, in many valve applications, operating potentials appear across high resistance circuits. The operator is often put in the position of observing a certain voltage on the meter, meantime trying to assess what the real voltage would be in the circuit, if the meter were not connected to it.

To eliminate such guesswork and allow circuits to be analysed under their true operating conditions, the instrument used to make the measurements ideally should not disturb the circuit potentials.

This is not the case with a normal type multimeter, which exhibits an input resistance of about 1000 ohms per volt. On the 250-volt scale, the meter resistance is 250,000 ohms, and is only 10,000 ohms on the 10-volt scale.

While multimeters are available with an input resistance of 20,000 ohms per volt, and represent a big step in the right direction, they are less robust than the usual type and do not completely solve the problem.

With a 1000 ohms per volt instument, in particular, the disturbance caused by the meter can be so great that the readings obtained may bear very little relationship to the true values.

To illustrate the point we set up the pentode audio stage shown in Fig. 1 and made measurements of the electrode potentials using a 1000 ohms-volt meter, a 20,000 ohms-volt meter and a vacuum tube voltmeter which imposed a 10-megohm loading on the circuit. The results obtained are given in the table next to the circuit.

Taking the VT Voltmeter readin as being substantially correct, t error in the 1000 ohms-volt instr ment is apparent. Conversely, t 20,000 ohms-voltmeter is fairly clo to the mark for this application, a though it has other limitations whi are mentioned later.

The voltage changes caused the voltmeter can be seen to va for different points in the circu The change in the high tension a cathode potentials is not measurabl because these potentials exist acro circuits of relatively low resistanc However, the change in screen a plate potentials is quite apparent b cause these involve high resistan circuits.

Even greater difficulties arise attempting to measure AVC voltag with a normal multimeter. In th case the circuit resistances are rec oned in megohms and application the meter virtually shorts out t AVC voltage.

MEASURING A.C.

Thus far we have dealt only wi the shortcomings of the multimet for DC voltage measurements, b even more serious effects occur whe measuring alternating voltages.

The aforementioned loading pro lems still exist, as would becom apparent if an attempt were mad to measure the audio output voltag of a stage as in Fig. 1, with a know signal voltage applied to its grid.

The voltmeter loading would r duce the apparent plate load of t amplifier and, with it, the gain the stage, giving a false reading.

In addition to this loading effe one must consider the response the instrument to various freque cies in the so-called "audio" rang For purposes of measurement, th range now extends from a few cycl per second up to at least 500 Kc.

At these "supersonic" frequenci the second major limitation of conventional multimeter becom very apparent. The copper-oxide re tifier, which is essential to its oper tion, has a frequency error whi may well become serious above abo 20 Kc.

BASIC PRINCIPLES

What is more, wiring and swit capacitances may shunt the high resistance multipliers quite marke ly and lead to gross error. measuring the output of a tape b oscillator, for example, errors of p or minus 50 pc are quite commo place with individual instrumen

The VT Voltmeter offers a so

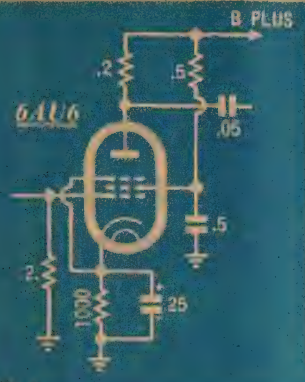

FIG. 1

MEASURING POSITION	METER RANGE	MEASURED VOLTAGES		
		1000 OHMS PER VOLT METER	20,000 OHMS PER VOLT METER	VTVM. INPUT RES. 10 MEG. ALL RANGES
B PLUS	1000	330	330	330
Va	250	43	67	69
Vg1	250	67	94	96
Vk	10	1.9	1.8	1.9

Illustrating the errors which can occur in the measurement of circuit potentials in a valve circuit due to instrument loading. The circuit is that of a 6AU6 audio amplifier, using circuit values from the valve manufacturers' data sheets.

ion to these two major problems 1) Input resistance and (2) Frequency error. It also offers certain other facilities and advantages which will be discussed later.

The basic principle is quite simple. A DC voltage requiring to be measured is not used directly to actuate a meter but is supplied instead to vary the bias on a valve grid. The resulting change in the valve's plate current is then noted on a meter, suitably calibrated in terms of input voltage.

Alternating potentials are applied to a thermionic diode or a "crystal diode", rectified with very little frequency error and used, as before, to vary the grid bias of a valve.

VT .Voltmeters appear in many forms, each designed to give a particular result. It may be helpful to review some of the better known circuit arrangements.

In its simplest form it consists of a milliammeter in the plate circuit of a negatively biased triode. This arrangement is shown in Fig. 2.

The triode is biased to cut-off (illustrated as five volts) at which the plate current, as indicated by the meter, is zero. If a potential of plus five volts is applied to the grid of the valve across the one megohm grid resistor, the meter will read full scale.

It will be seen, with this arrangement, that the loading on the circuit is 1 megohm—a figure which could conceivably be doubled or trebled if need be.

CIRCUIT LOADING

Conversely, if an ordinary meter were used directly to give the same deflection sensitivity, it would have an internal resistance of only 5000 ohms. By using the most sensitive meter movement likely to be chosen, the resistance would still be limited to 100,000 ohms.

However, this simple type of vacuum tube voltmeter still leaves much to be desired to make it into a satisfactory general purpose instrument.

It is highly desirable that the meter will be able to measure DC negative as well as positive voltages without the need to change over the instrument leads. For a valve circuit to operate in both directions it must be biased to the centre of its grid voltage plate current characteristic and not to the plate current cut-off point as in Fig. 2.

Further, in order to guard against calibration errors due to valve ageing effects, it is desirable to provide a large degree of negative voltage feedback in the instrument.

This can be accomplished by including a high value of resistance in the cathode lead of the valve. The inclusion of this feedback and the additional networks that are required to bring the valve electrodes to the correct operating potentials are shown in Fig. 3.

If the valve is biased to the middle of its characteristic, a meter in the plate circuit would read part way up the scale with no voltage input to the valve grid. This would have to be treated as zero, the useful length of scale therefore being considerably shortened.

To overcome this difficulty the circuit of Fig. 4 is often used. In this circuit the plate current of the valve is not measured directly but rather the potential drop that it produces across its cathode resistor.

One end of the meter is connected to the variable potential cathode and the other to a constant voltage. This voltage is obtained from a potential divider across the B-plus supply.

It is important in this circuit that the current drawn through the potential divider be considerably more than that through the valve. This is to keep the "backing-off" voltage at a steady value as the valve current varies with the measured voltage.

The lower end of the divider is made adjustable so that it can be used as a meter zero set control. A resistor wired in series with the meter will set the meter deflection for a given input voltage to the valve grid.

EXCELLENT METHOD

This method of setting the voltage ranges has much to recommend it, as it does not upset the DC operating potentials of the circuit.

However, if the valve is to operate on the linear portion of its characteristic, the input which is applied to the grid of V1 must always be less than the cathode voltage drop, minus the required grid bias for the tube.

This is one of the limiting factors of the circuit as in figure 4 and it is usual to restrict the input to a maximum of 150 volts at the grid. Any increase in the voltage range required beyond this point must be obtained by the use of a potential divider in the grid circuit.

One further modification that can

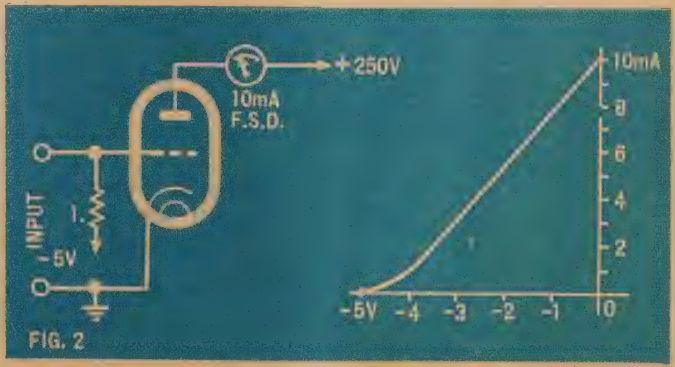

FIG. 2

A basic form of vacuum tube voltmeter, illustrating the principle of the instrument.

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be made to the circuit to improve its stability is to replace the potential divider with another valve. This arrangement is shown in Fig. 5.

Also included in this circuit is an improved method of setting the meter zero. This is accomplished by slightly varying the plate voltage applied to the two valves. This in turn varies their plate currents and the voltage drop across the cathode resistors. When the cathode voltages are equal, the meter will show no deflection.

When Fig. 5 is redrawn as in Fig. 6 it can be seen to be a bridge circuit. Any changes which take place in the one arm of the bridge network due to B-plus changes will take place equally in the other arm and the zero of the meter will remain fixed.

So much for the meter indicating circuit. We now come to the problems associated with the grid input circuit to the valve V1.

GRID CURRENT

In order to keep the input resistance of the vacuum tube voltmeter high, the value of the first valve grid resistor must be kept high. This introduces certain difficulties when the value is greater than a megohm or so.

In all valves, some grid current tends to flow, developing a bias across the grid return circuit. The current flow may be due to actual emission from the grid structure, being aggravated when the grid becomes hot or when its surface is contaminated by cathode coating material.

Again if minute quantities of gas are present in the envelope, collision between gas molecules and electrons moving from cathode to plate releases positive ions which are ultimately attracted to the grid. These produce a positive potential which is reduced when the grid resistor is shunted or shorted out.

This shorting out of the grid resistor will occur in the case of the simple circuit of Fig. 5, when the instrument is connected across a low value of resistor to measure the voltage drop.

If the meter zero is set with the leads open-circuited, when they are connected across the resistor the meter deflection will be the result of two things: (1) the voltage drop across the resistor and (2) the change of grid voltage due to shunting the resistor across which the gas current voltage is developed.

As the meter cannot differentiate between the two effects, the indicated result will be incorrect. Of course, a similar thing will take place if the instrument is set to zero with the leads shorted and is then used to measure the voltage drop across a high value resistor.

FURTHER COMPLICATION

A further complication occurs when we introduce a voltage divider in front of the first valve grid. As previously explained, this divider is necessary to restrict the input, applied to the grid of the valve, to a value which will allow it to operate within the linear portion of its characteristic.

As the grid is tapped down the divider, so the value of resistance between it and earth will be reduced, thus changing the voltage developed by the gas current.

It can be seen that for the instrument to be of any practical use, it must be substantially free from gas current effects. This is particularly important because higher values of grid resistance than 1 megohm are to be desired if they can be used.

The major factors which control the amount of gas current are, the plate current at which the valve is operated and the amount of gas in the valve.

The amount of gas in a valve will depend upon the completeness of the evacuation during manufacture and the amount of cleaning up that the getter has effected.

It is not unusual to have to select individual valves for the lowest gas current characteristics, when they are to be used in vacuum tube voltmeters.

Of course, the larger the valve electrodes and the more that there are of them, the greater is the chance of gas being released during the life of a valve. For this reason the use of miniature triodes has much to be said in its favor. Also the availability of twin triode valves allows us to satisfy another requirement.

If we are to use a balanced bridge circuit as in Fig. 5, it is advantageous if the valve in either side of the network is in a common envelope. Thus any changes which occur within the valve envelope will be common to both valves and the effects will tend to balance each other.

Apart from the selection of a valve having a low gas content, the only way of reducing the gas curent effects while retaining a high value of grid resistor is to lower the plate voltage.

However, if we reduce this voltage to a low enough value to overcome grid current effects, the plate current is no longer sufficient to operate a reasonably robust meter.

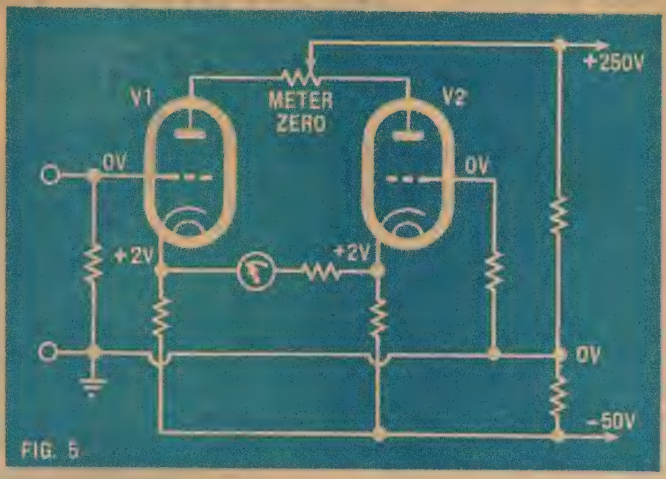

FIG. 5

In this circuit the B-plus potential divider has been replaced by a valve to balance the circuit against changes in the zero set position with change in the B-plus voltage

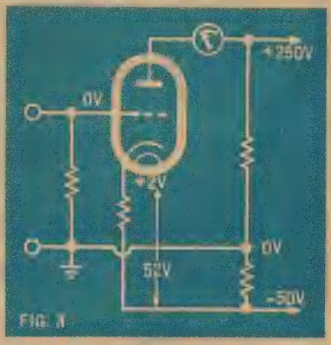

FIG. 3

The basic vacuum tube voltmeter with the addition of negative feedback in the cathode circuit to reduce the effects of changes in valve characteristics.

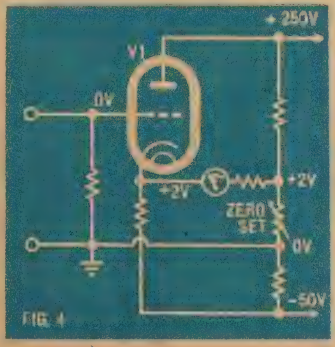

FIG. 4

The basic circuit modified to allow the meter to be set to zero.

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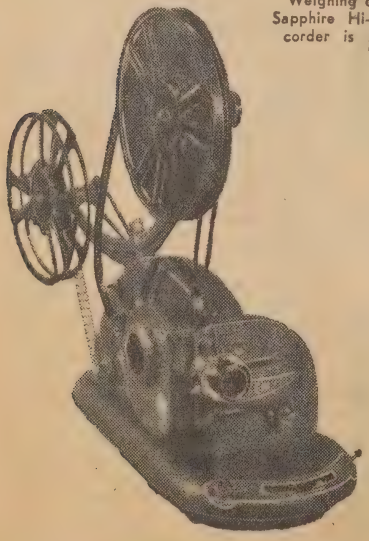

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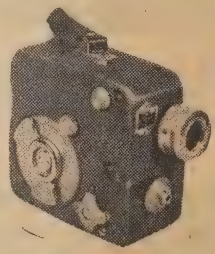

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It is at this stage that we find desirable to separate the vacuum ibe voltmeter into two distinct perating sections—the meter actu-ing section, which we have already vered, and another section which as a high input resistance and is perated at low plate voltages to vercome the undesirable gas cur-nt effects.

A basic circuit of this type is nown in Fig 7. It satisfies all the quirements that we have already scussed and also retains the bal-nced circuit arrangements.

The double triode V3-V4 is a thode follower stage operated low plate voltage. Typical circuit oltages are shown to illustrate the eneral operation of the circuit.

At such low operating voltage the id resistor of V3 can be short-cir-uited without any change in the ate current, due to gas curent ef-cts. Thus, we can make the resis-r R5 a voltage divider and tap e grid of V3 down it to give the arious ranges required.

CATHODE RESISTORS

The cathode resistors of V3 and 4 are made high in value to stabi-se the circuit against valve changes uring life. A typical value for these esistors would be 1 to 10 megohms. hese same resistors can be seen om the circuit to serve as grid esistors for V1 and V2.

This might raise the question in e reader's mind of the same prob-m again of high grid resistors, id their attendant shortcomings. owever, in this case, although the id resistor is high it is constant nder all conditions of operation. nus once the circuit has been ad-sted to offset the developed gas rrent grid voltage, no changes will cur.

We now have the main portion our vacuum tube voltmeter, al-ough in its present form it is only uitable for the measurement of C voltages of one polarity. To easure voltages of the other polar-y it is only necessary to provide change-over switch in the meter rcuit.

This is possible because as we scussed earlier in this article, the ive operating conditions can be arranged that they are on the near portion of their characteristic id can be driven in either direc-on.

Another method which could be dopted to measure voltages of the other polarity would be to feed them to the other grid of the balanced pair.

The next problem to tackle is that of adapting of the circuit to read AC voltages from low audio frequencies to the highest possible radio frequencies.

It is almost universal practice to use a diode rectifier and its application calls for some careful consideration. Unless attention is paid to this part of the circuit, the care taken to obtain a stable basic section is wasted.

The basic diode rectifier circuit is shown in Fig. 8. This is a shunt connected diode and is similar to that used in AVC systems. The diode load is the voltage divider of the first valve and would replace R2 in Fig. 8.

The capacitor C1 in the circuit of Fig. 8 serves a dual purpose. One is to block any DC voltage that may accompany the AC voltage that is being measured and the other to act as the charging capacitor for the circuit.

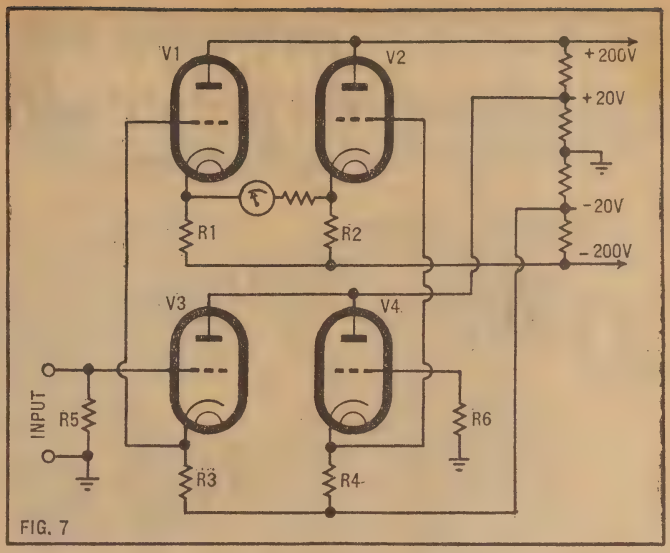

FIG. 7

In this circuit cathode followers have been added to the circuit to overcome gas current effects.

Its value needs to be such that it does not appreciably discharge between cycles, even on the lowest frequency that it is required to measure.. This means a capacitor of fairly large value and therefore physically large.

While this meets the requirements at the low frequency end of the measuring range it does place some limitations on the high frequency end. At the high frequencies the value of the capacitance is not so important as the series inductance of the unit, which needs to be kept to the lowest possible value.

Also the larger that the capacitor is physically, the higher will be the input capacitance of the probe because, for a given size shield, the capacitor will be closer to the outer earthed case.

COMPROMISE POSSIBLE

In practice, with the high values of diode load and grid resistors that are used, it is not too difficult to obtain a satisfactory solution, provided that the above requirements are born in mind.

Typical values for the circuit in Fig. 8 would be R1-5 Megohms, R2-10 Megohm divider, C1 and C2-.02 mfd each.

Some thought must also be given to the type of diode to be used. This must be of the thermionic type as the Germanium diodes have significant limitations.

They are fairly low impedance devices, when considered for the application to a high input impedance vacuum tube voltmeter. Also the input voltage which can be applied to them without damage is limited in most types to the order of 50 volts.

This is not satisfactory for a general purpose instrument and the crystal diode is only used where it has a specific application. Such a case is at very high frequencies where it is used in preference to the thermionic diode.

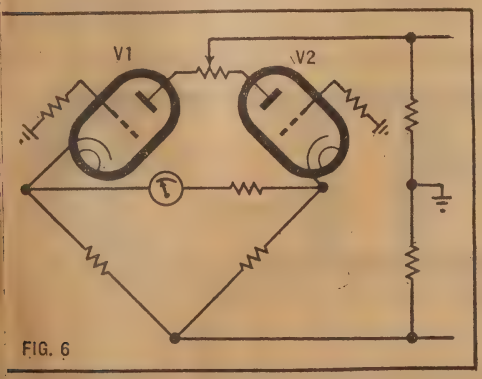

FIG. 6

This is the circuit of Fig. 5 redrawn to show its similarity to a bridge circuit

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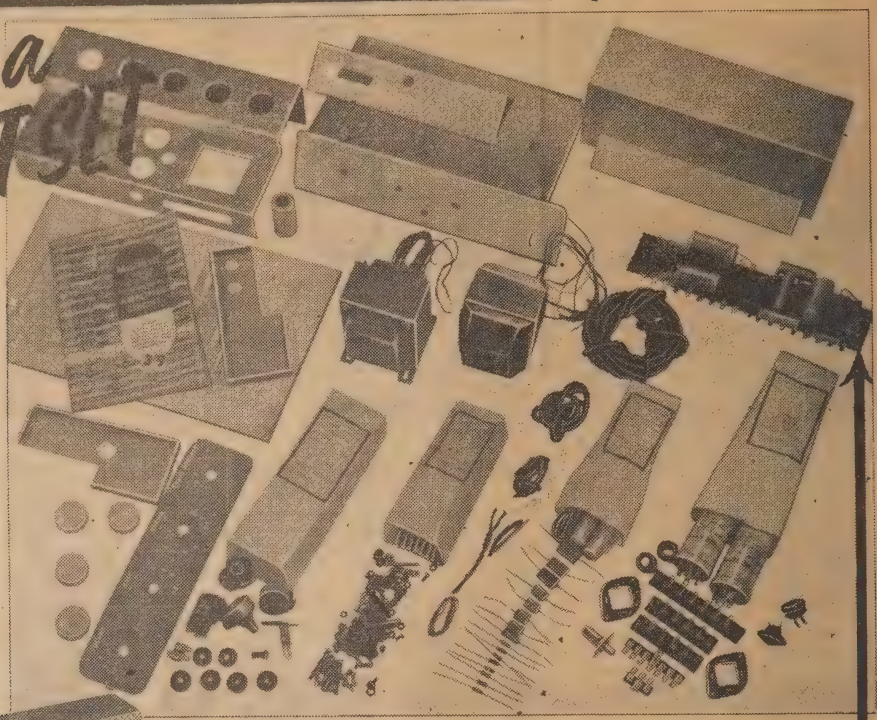

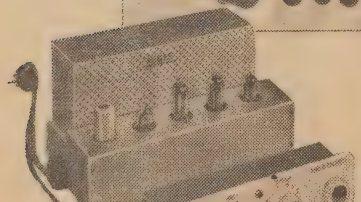

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Even the normal diode has its difficulties in regard to voltage ratings. The type of diode that we require is one that is designed for high frequency operation, is small in physical size and preferably of the type having two diodes in the one envelope.

This suggests a valve of the 6AL5 type. This valve has a peak inverse voltage rating of 330 volts which would correspond to an RMS input of 115 volts. For a general purpose instrument a high voltage range of at least 1000 volts is essential.

VOLTAGE RATINGS

The general practice adopted is to use a diode of the 6AL5 type and ignore the ratings. In practice it is found that the diodes have an adequate life and are quite satisfactory. Probably one of the main saving factors is, that although a 1000 volt range is provided, the instrument is only rarely used at its full rating.

Mention was made in the discussion that a valve having two diodes in the one envelope is to be preferred. This is so that the second diode can be used to balance out undesirable contact potential effects.

Contact potential is the negative voltage that appears on the plate of a diode with only the load resistance and filament voltage connected. This voltage is due to the initial velocity of the electrons emitted from the cathode being sufficiently high to reach the plate, without the need for an accelerating potential being applied to the plate.

The usual method of overcoming this effect is to connect a second diode to the other side of the bridge network to balance it.

As the contact potential is developed across the potential divider, it will be reduced as the input of the first triode is stepped down the divider. For this reason it is necessary to have a second divider on the output of the contact potential balancing diode to keep the zero balance at all settings of the divider.

By including the two diodes in the one envelope any changes of characteristics which take place during the life of the valve will be more likely to be balanced. This is particularly the case with contact potential which may vary from an initial one volt to half a volt during life.

It is because of this variation that it is inadvisable to overcome the voltage developed by contact potential with a fixed voltage from the power supply.

DIODE CIRCUIT

The performance of the diode circuit is not disturbed by the value of the resistance across which it is measuring as the capacitor C1 blocks the DC path. Thus we have not had to aim at removing the contact potential, as we did with the triode gas current, as it is possible to balance it out, knowing that this balance will not be upset by the measuring circuit.

There is one further facility that can conveniently be added to our complete instrument, and that is, resistance measurement.

The basic circuit used is shown in Fig. 9 and is capable of most satisfactory results. If we assume that the standard resistor be made 100,000 ohms, when the unknown is equal to the same value, the meter will read half full scale. This is of course based on the assumption that the meter sensitivity has already been arranged to be 3 volts full scale.

By making this standard resistor of various values from 10 ohms to 10 megohms we can cover the range of resistance measurements from a fraction of an ohm to greater than 1000 megohms.

READS CORRECTLY

The circuit has the further advantage of reading in the correct direction. That is, the highest values of resistance will be on the right hand side of the scale. This is because the meter will read full scale deflection when there is no resistance connected across its terminals.

It is very important for this type of resistance measuring circuit that the vacuum tube voltmeter have a very high input resistance, as otherwise this would load the value of resistance which it is desired to measure.

This completes the survey of the general requirements and characteristics of vacuum tube voltmeters and in the next issue we will describe an instrument incorporating most of the features so far discussed.

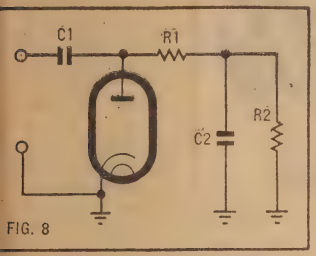

FIG. 8

The basic diode rectifier circuit used for vacuum tube voltmeters. This circuit responds to the peak value of the positive half cycles of the AC input although it is usual to calibrate the instrument in terms of the RMS value of a sine wave.

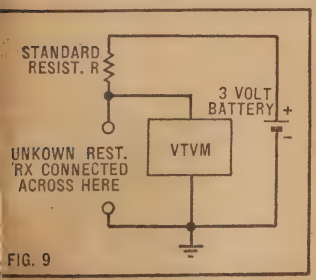

FIG. 9

The basic circuit used with vacuum tube voltmeter for the measurement of ohms.

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A COURSE IN TELEVISION

PART FOUR—PICTURE TUBES AND CAMERAS

Though few readers may ever have anything to do, in a practical way, with television camera tubes, it should nevertheless be helpful to have some appreciation of how these devices work. Their development follows naturally enough on the display tubes described last month.

EARLIER in the series, we explained the basic principles by which mechanical television "camera" systems generated a signal proportional to the light and shade of the scene to be transmitted.

Though the various methods served their purpose at the time, they suffered certain severe limitations. In the first place, they were not readily adaptable for high definition systems, because of the extreme complexity and the high operating speeds required of the scanning device.

As at the receiving end, the only possible solution lay in the use of electronic scanning — some adaption of the cathode-ray principle explained last month.

The second major limitation was lack of sensitivity — an inability to produce adequate electrical signals from a variety of subject matter under varying light conditions. The basic problem is not difficult to appreciate.

You will recall that one approach was to have the subject in a darkened room, illuminated only by flying spot of light from an arc lamp and a scanning device of one kind or another. Reflected light collected by phototubes produced the picture signal.

While satisfactory enough for a plane illustration or a single actor, the system was not satisfactory for complex scenes or out-of-doors, where the flying spot had to compete with ambient light.

REFLECTED LIGHT

The alternative was to have the subject or scene brightly illuminated but admit to a phototube only the light reflected from the scene at each instant through the scanning aperture. The difficulty here was that extremely bright illumination was necessary, otherwise insufficient signal was produced by the phototube for subsequent amplification.

Naturally enough, any decrease in the size of scanning aperture, in the interests of improved definition, only magnified the problem of getting enough light through it to produce a signal!

The problem therefore, was not only to devise a workable electronic camera system but to produce one that would exhibit better sensitivity than had hitherto been possible.

Actually this objective has been achieved in a remarkable degree, to the point where television camera sensitivity has far outstripped photographic cameras and even overtaken the sensitivity of the human eye.

Present day cameras are capable of operating in the brightest sunlight or, conversely, they can produce a usable picture with no more illumination than is afforded by a lighted match.

As might be expected, performance of this order is not obtained cheaply and a modern studio-type television camera is a complex and expensive piece of equipment. Figure 23 will give some appreciation of this fact.

At the front of the camera is a turret of optical lenses having different focal lengths and capable of capturing a close-up, intermediate or distant view of the subject to be televised.

The optical image is scanned by an electron beam in the camera tube and transformed into electrical impulses. The camera contains in-built amplifier stages and equipment to deflect the beam within the camera tube, in accordance with the required scanning procedure.

Various optical and electrical controls are provided for the use of the operator, while the upper section of the camera houses a cathode-ray picture display unit, which allows him to view the image as it would appear on distant cathode-ray screens. In all, the interior of the camera is a mass of wires, valves and small components, which only a specialist could be expected to understand or to service.

The development of the modern picture tube is an interesting story, which takes in many famous names —Hertz, Blanck, Einstein, J. J. Thompson, Carey, Rignoux, Fournier and many others. However, the more spectacular progress dates from about 1930, following work by the German scientist, Von Ardenne.

Since then, more or less parallel research and development has gone on in several countries, notably England and America.

TYPES OF TUBE

It is obviously not possible — or necessary—to explain all the individual tube types, but an examination of some of the more important ones will give the reader a good idea of the principles involved.

A basic item in most picture tubes is an electrode which is referred to variously as a photo-cathode, a mosaic screen, a signal plate or a target.

It commonly takes the form of a mica sheet, several square inches in area and only about .001in thick. One side is coated with a continuous film of metallic silver.

On the other side are deposited countless particles of metallic silver,

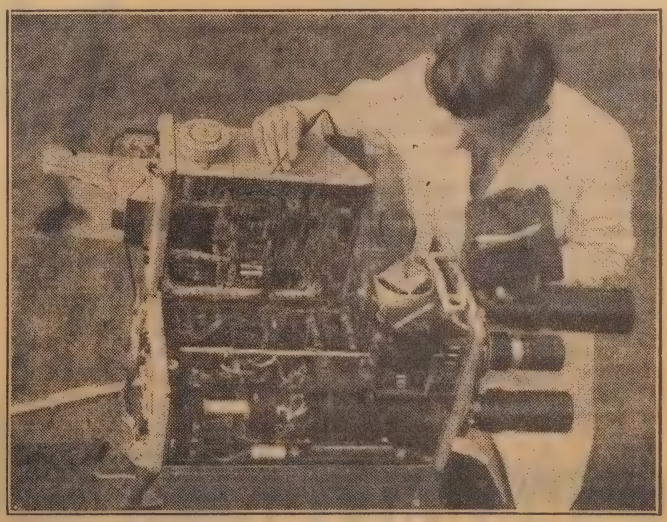

Figure 23: An inside view of a television camera used for outside broadcasts by the BBC. It uses an image orthicon pickup tube and the auxiliary circuits involve 41 valves, 190 resistors, 120 capacitors, a mass of intricate wiring and an in-built cooling unit. It uses a 4-turret lens and this, together with focus and iris controls, can be remotely controlled, if desired. Sections are demountable for ease of service or replacement.

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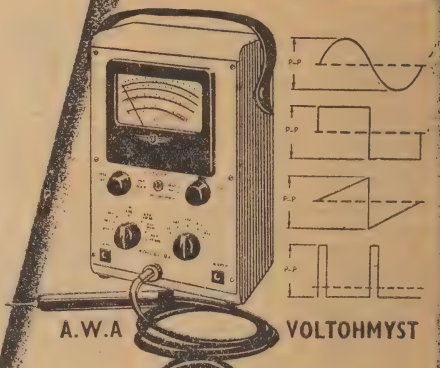

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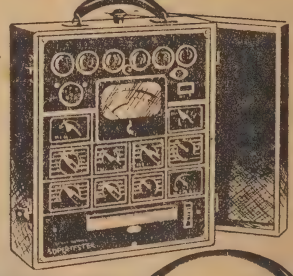

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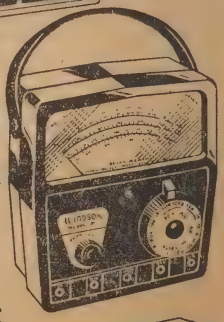

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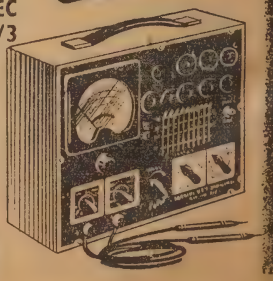

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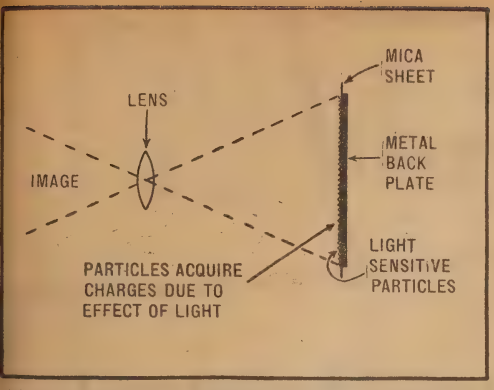

Figure 24: Basis of most camera tubes is a light-sensitive mosaic screen, which acquires a charge on various points on its surface, depending on the brightness of the optical image focused upon it. Figure 25 shows how the effect is utilised in practice.

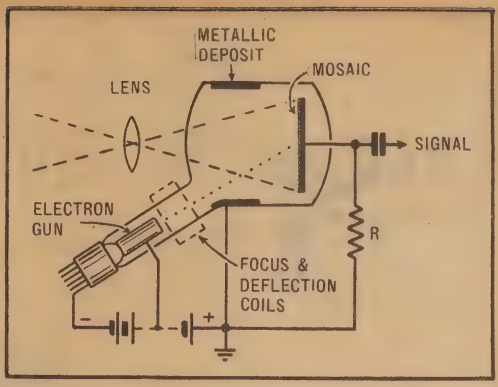

Figure 25: Illustrating the construction of the simple "Iconoscope" or "Emitron" type camera tube. Charges on the mosaic are released by the electron beam as it passes in its scanning routine, generating a signal across the "load" resistor "R".

hich are oxidised and made light nsitive by treatment with caesium. he particles are quite separate and istinct, like globules of water on greasy surface.

There is obviously a certain capaci- nce between each particle and the ack plate, so that the mosaic, in fect, can be regarded as an as- mbly of countless tiny capacitors, ith one common plate, and every her plate photo-sensitive.

Under the influence of light, a otential difference tends to build p between each of the silver par- cles and the back plate.

If an image is projected on to the hoto-cathode by ordinary optical eans, the individual tiny capacitors nd to acquire a charge proportional the light and shade of the picture. The effect is illustrated in figure .

The function of the tube, as a whole, is to scan, release and utilise these tiny charges converting them into picture signals.

Possibly the simplest form of pic- re tube was known in America as e "Iconoscope" and, in England, der the trade name of "Emitron". is illustrated in figure 25.

CTION OF LIGHT

The photo-cathode, or mosaic, is ounted in the main body of the be. The scene to be televised is cused through an ordinary lens stem on to the light sensitive sur- ce.

Under the influence of the light d shade, the tiny silver particles nit electrons and begin to acquire positive charge. The charge con- nues to build up, according to the cident light, until it is ultimately leased by the electron beam.

It is important to note that light falls on the photo-cathode all the time, and that the charging process by the minute condensers is likewise continuous.

When the charge is ultimately leased, it is quite substantial as result, and this makes an import- t contribution to the sensitivity of e Iconoscope or Emitron.

For the purpose of scanning, a thode ray beam is generated and cused by the electrode structure

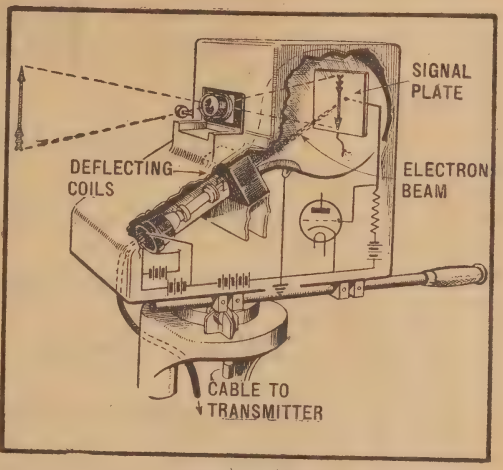

Figure 26: This diagram indicates how the Emitron or Iconoscope type tubes were used in early television cameras. Subsequently, coupled viewfinders were used to give the operator an optical image of the scene being televised. This was later superseded by cathode-ray presentation of the image, derived from the camera's own generated signals. Compare this diagram with figure 23.

in the neck of the tube. By means of deflecting coils, the beam is made to scan the surface of the mosaic, line by line, in the required fashion.

The precise effect of the electron beam on each tiny condenser is rather complex, and a detailed examination is hardly warranted at this juncture.

Sufficient to say that electrons from the beam replace those which have been emitted as a result of the photo-electric effect and discharge the tiny condensers as it passes across them.

The resulting change in potential is naturally communicated to the common back plate and a voltage is generated across the load resistor "R". This is subsequently amplified, becoming the picture signal which modulates the transmitter.

Primary and secondary electrons released from the photo-cathode are collected by a ring or metallic coating inside the body of the tube.

Another approach to the whole problem was represented by the "Image Dissector" tube of P. T. Farnsworth, as illustrated in figure 27. This used the same photo-cathode idea, but employed the resulting electron emission in quite a different fashion.

Instead of being allowed to collect as a charge on the mosaic elements, the electrons, which are emitted due to incident light, are immediately accelerated forward from the target by an accelerator anode.

The position and potential of the anode is so arranged that the electrons are not dispersed but move forward, retaining a fixed relationship to other electrons. In other words, each photocathode element emits its own electron "beam", which is accelerated forward without becoming confused with adjacent "beams".

PATTERN OF ELECTRONS

Thus the distribution of light on the photo-cathode is reproduced as a density pattern in the electrons moving continuously toward the front of the tube.

To produce a scanning effect, other magnetic fields are employed to swing the whole electron image bodily from left to right and up and down, according to scanning requirements.

In their path is a tiny target and, as the electron columns swing back and forth, some electrons col-

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e with it, inducing varying ounts of current in the external cuit.

Thus the scanning involves swing- an electronic image past an aper- e, instead of sampling a station- image with a moving beam.

t is important to note that the rnsworth tube lacks the storage ect of the Iconoscope, and it is ubtful whether it would work at without the services of an elec- n multiplier. The operation of s device is interesting.

Electrons striking the target re- se other electrons by a second- emission effect. These second- electrons are attracted to a ond anode, which is operated at a newhat higher voltage and strate- ally placed in relation to the ginal target electrode.

GNAL BUILDS UP

Electrons released by this second ode impinge on a third anode and on. The signal ultimately builds to proportions which allow it to amplified externally by conven- nal valve circuits.

The Dissector tube is not used to y extent nowadays, but a com- nation of some of the ideas with original iconoscope allowed more nsitive picture tubes to be pro- ced.

Among these were the Super nitron and the Image Iconoscope, ich are illustrated in figure 28. ese tubes separate the functions photo-emission and storage.

The photo-cathode is transparent, d the image is focused on the rear, aching the photo-electric elements rough the mica sheet and a micro- pically thin metallic layer.

Electrons emitted by the photo- hode are accelerated away from surface and focused by the posi- ely charged anode and by a mag- ic field.

They impinge on a second mosaic d form, as it were, an electron age upon it, corresponding in de- to the visual image projected on the photosensitive surface.

The second mosaic is designed to e the best possible storage effi- ncy and, in practice, tubes of this neral type show an increase of eral times in sensitivity over the lier tubes.

Another interesting variant was vised, known in America as the rthicon". Though not separate- illustrated, this employs a single otocathode like the Iconoscope or Emitron, but transparent to light, in the "image" tubes just dis- sed.

IAL CONSTRUCTION

The image is focused through one of the tube on to the rear of mosaic, while the gun structure upies the other end of the tube. This arrangement puts the gun, mosaic and the image all on same axis and eliminates the d for the obliquely mounted neck n in the Iconoscope and Emit- . It avoided problems with pezium distortion, cleared the s mount and made possible the of a lens turret.

t must be remembered, of course, t the sketches and explanations intended to illustrate basic prin- les only.

All the intensive research which nt into the production of these

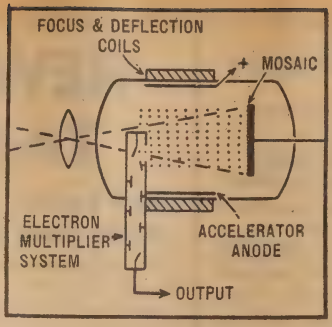
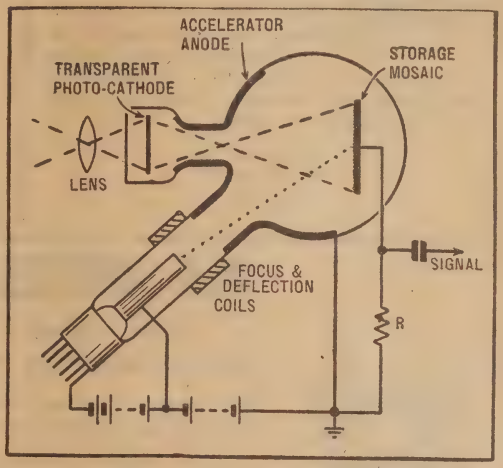


Figure: 27 (above): The Farnsworth image dissector is fundamentally different from other tubes. Note electron multiplier, without which it could scarcely function.

Figure 28 (right): The Image Iconoscope and Super Emitron tubes employ a special photo cathode as well as a mosaic screen. Tubes of this general type have been used up till quite recently for televising films and other applications where sensitivity is not a serious problem.



earlier camera tubes, culminated ultimately in the production of a much more ambitious type of tube, as used in most modern full-sized cameras. This is best known as the "Image Orthicon," although similar tubes are manufactured under other trade names, such as the CPS Emitron.

Physically the Image Orthicon looks rather like a projection display tube, being about 15 inches long and about three inches in diameter at the head. Quite recently a somewhat larger version of the tube has been produced under licence in England.

The basic principles are illustrated in figure 29.

Electrically, the Image Orthicon is divided into three distinct sections, an image compartment, a scanning section and an electron multiplier along similar lines to that in the Farnsworth Image Dissector.

Light rays from the image are focused on to a transparent photo-sensitive mosaic. Electrons are emitted from the inner surface in proportion to the light and shade of the image.

These primary electrons are accelerated away from the photo-cathode by an anode structure, and an extremely fine mesh-like grid, which carries a positive potential The electrons pass through it at relatively high velocity and strike a second mosaic having high secondary emissive qualities.

The base for this second mosaic is actually a film of glass one-tenth of 1-mil thick. It is so fine that it is transparent to electrons and the charges which accumulate on the front can influence or be influenced by electrons from an electron gun at the rear.

When electrons strike the front of the glass screen, they create on it an electron image, equivalent in density to the visual image on the photo-cathode. The impact of these primary electrons causes secondary emission, and individual particles of the mosaic acquire varying positive charges as a result.

The rear of the glass target is scanned by a low velocity electron beam, the electrons being slowed down just before they reach the rear surface.

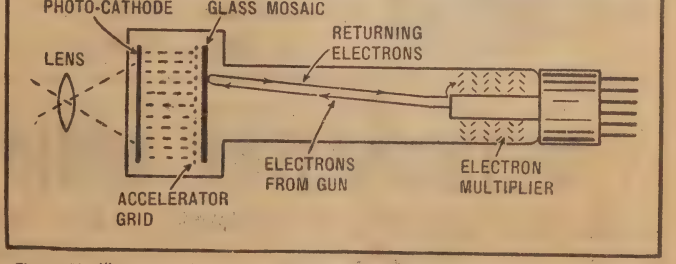


Figure 29: Illustrating the Image Orthicon tube—one of the most advanced designs yet evolved. This tube or equivalent versions of it is employed almost universally nowadays in full-sized TV cameras.

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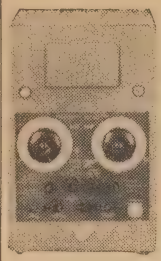

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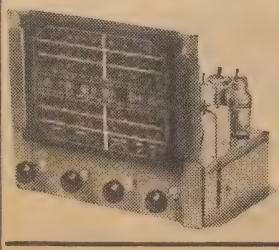

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The beam gives up just enough ectrons to neutralise the positive harges at each point of the mosaic, nd the remainder of the electrons mediately reverse direction and turn to a structure surrounding e gun.

This structure is actually a form electron multiplier which greatly nplifies the variations in electron rrent from the target.

The Image Orthicon, therefore, mbines the outstanding features all other tubes previously men-oned and the result is a tube of gh sensitivity and small size.

This is the tube which has made ssible the degree of sensitivity, to hich reference was made early in e article. It can operate easily in ite ordinary degrees of illumina-n, so that the problems of high ensity lighting are largely ob-ated.

Where necessary, it can produce able pictures under very adverse nditions, so that telecasts of out-or sporting fixtures can continue ng after failing light has com-lled newsreel cameras to give up.

PTH OF FOCUS

Where ample light is available, e high sensitivity of the Image thicon permits the optical system be stopped down, ensuring a good pth of focus. A complete camera ilt around the Image Orthicon is tured in figure 23.

For all that, the Image Orthicon not by any means perfect and rious technical limitations have to be overcome. It is also a ry expensive tube and this has rred efforts to produce a type tube which would be, perhaps s sensitive, but more applicable low cost and/or more readily rtable cameras.

The most effective answer to this oblem at the moment is found in ube developed by RCA in America d known as the "Vidicon". This e provides the basis for the many niaturised TV cameras which have ently been devised, notably for lustrial and military applications.

t differs from all other pick-up es thus far discussed in that it es not rely on the property of oto-emission. As we have seen, s involves focusing the light age on to a mosaic screen, which its electrons from points on its face, depending on the strength of impinging rays.

The electrons so emitted are used various ways, according to the e design but ultimately initiate a rrent in the output circuit.

TERNATIVE IDEA

An alternative principle, which is d in the Vidicon tube, is that of oto-conductivity, by which in-ent light is made to vary the con-cting qualities — or the resistance of the target structure.

The significant point about this ond principle is that it offers a vast rease in photo-sensitivity, repre-nting the difference between about microamps per lumen for photo-ission to tens of thousands of croamps for photo-conductivity.

(The high sensitivity of selenium d like substances to light has long en appreciated in connection with otographic exposure meters.)

However, while many photo-con-cting materials are known, there re practical difficulties in their rly application, notably spectral

DETAILS OF THE "VIDICON" TUBE

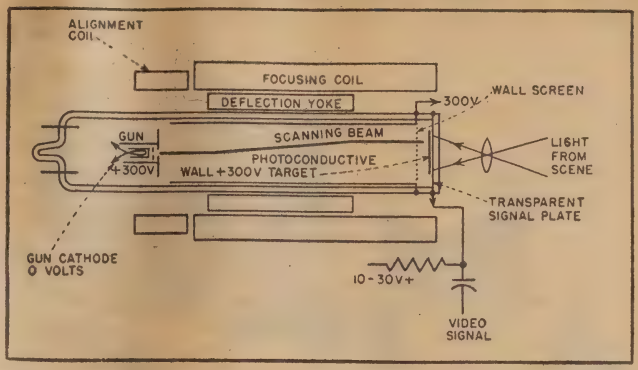


Figure 30: Cross-sectional diagram of Vidicon photo-conductive television camera pickup tube. It combines useful sensitivity with simplicity of construction.

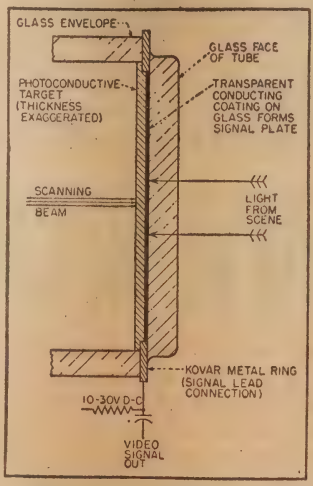


Figure 31: Details of the target construction in the Vidicon photo-conductive camera tube.

response, a lack of sensitivity, retention of image patterns and the development of spurious spots on the target.

After considerable work on the principle in the middle 30's, it was dropped in favor of photo-emission.

Intensive work on photo-emitters during the war, for infra-red detectors, threw much new light on the subject and encouraged RCA engineers to try again.

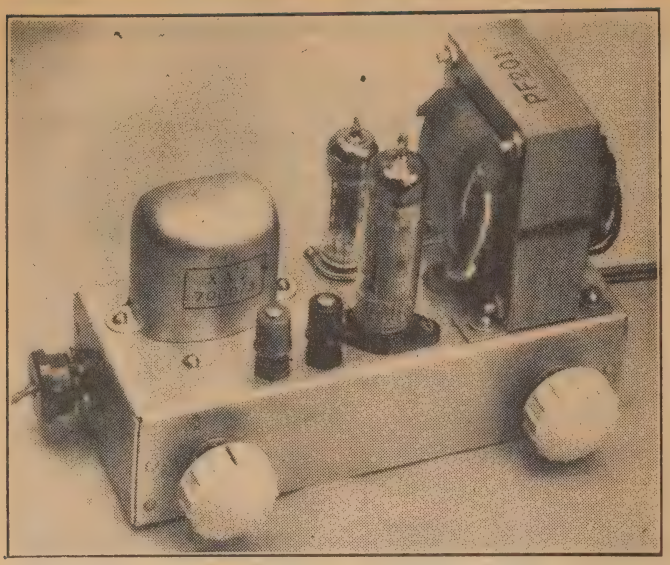
It was realised that, if the principle could be applied successfully in practice, the higher natural sensitivity would obviate the need for multiplier stages and much of the complication surrounding the Image Orthicon.

The first successful tube, using these principles, was announced in 1950. Christened the "Vidicon", it was only one inch in diameter and six inches long, being but a fraction the size of the Image Orthicon.

It was credited with an ability to resolve some 600 lines, on its small screen and a target sensitivity of 300 uA per lumen. This meant that it could transmit a noise-free picture of good resolution, using an f2 lens and in a level of light common in factories and laboratories.

(Continued on Page 119)

Figure 32: This is the kind of use military leaders envisage for miniature Vidicon equipped TV cameras—relaying enemy movements visually back to headquarters.



Only 2¾in from front to back this little amplifier can be placed knobs uppermost underneath the motor board of most record players.

SIMPLE 2-VALVE RECORD PLAYER

If we need a reason for producing yet another amplifier, this time it is the release of a special high output turn-over type crystal cartridge by Acos under the type number G.P. 59-3. Output direct from the crystal is sufficient to be fed directly into a power valve which will then pass on to the speaker more than sufficient output for outdoor dancing on the coming summer evenings or quiet listening in the living room according to your mood.

THERE is no question of anything radical about the idea. In fact, we recollect having described baby amplifiers conforming to the same general prescription several times before.

It's going back a long way now, but the first of the series was tried with early six-pin valves such as the 42. The pickup was one of the crystal "rock crushers" of the same vintage and the speaker had a separate winding to provide the excitation for the field.

If such a simple amplifier was satisfactory in those days how much more so now when improvements have taken place in practically every component.

Take the pickup for example. Not only have factors such as stylus pressure and compliance improved to the benefit of record wear but the output has largely been preserved. The remark applies to crystal pickups in general as well as the G.P. 59-3, but the latter is outstanding in this respect with an output of the order of 4.0 volts on standard 78 rpm recordings and 1.0 volt approx. claimed by the manufacturers for 33-1/3 rpm pressings.

That the manufacturer's data is correct was confirmed by our own tests. An audio signal generator was connected to the input of the amplifier and a cathode-ray oscilloscope to the output. The output of the generator was adjusted until the amplifier, with sine wave input, was on the verge of overload and the size of the pattern on the CRO screen noted.

OUR TESTS

With the same setting of the CRO gain control and the amplifier fed from the G.P. 59-3 cartridge on an average 78 rpm recording, the 6BQ5 was driven to the overload point with the gain control less than full on.

This amounts to something of the order of 4 watts, as much or more than many full sized radiograms, so that the small size is no guide to the punch the "mighty midget" can deliver.

The crystal cartridge we mention is sold as a separate replacement unit. The manufacturers state that it will physically replace the G.P. 25-1, G.P. 29-2 and HGP 37-1C and also will fit two Garrard adaptors and the Decca turnover pickup.

At the same time there is no doubt that there are many other arms which could be modified without too much difficulty to take the cartridge. Further than this, if you are careful to consider all the requirements, it would not be too hard to make a suitable arm complete.

One of the most important points to watch is the tracking weight which should be of the order of 10 to 12 gms. If too high, both record and stylus wear will be excessive while if it is too low, the stylus may tend to jump out of the groove, particularly when dealing with heavily recorded bass notes on 78 rpm recordings.

CRYSTAL PICKUPS

Although we mention the G.P. 59-3 particularly, any modern crystal pickup in good order will give a good account of itself. The power output may not always be sufficient to fully load the valve, but take it from us there will be plenty of noise.

Apart from the pickup, the power valve is responsible to a large degree for a happy situation, in that it is able to deliver full output with an input of about 5.5 volts rms. Compare this with one of the earlier pentodes requiring up to 11 or 12 volts rms.

Speakers also have received plenty of attention from designers and they certainly make better use of the audio power fed into them than did the earlier types. Most of the credit is due to special alloys which allow strong magnetic fields to be produced with a relatively small magnet.

You are convinced! The simple amplifier is just what you need. How then do you set about building it?

Many readers will go along to a radio dealer and order a complete kit of new parts. This will include the chassis with all holes punched because the chassis people have already been supplied with a blueprint of the chassis used in our own model. Assembly then becomes simply a matter of mounting the parts and connecting a few wires —a job for after tea one evening or at the most two evenings if you like to work very carefully.

You can vary the order of assembly as you please but probably the easiest way is to mount all large components first. The power transformer, the speaker transformer, the volume control and the tone control and al

the valve sockets and speaker socket.

Before installing the choke, it is as well to connect the two secondary leads of the speaker transformer to the speaker socket and also the two primary leads to the screen and plate (pins 7 and 9, see wiring diagram) of the 6BQ5 output valve respectively.

The choke can then be bolted to the side of the chassis where it will not interfere with the rest of the wiring job.

Experts will probably work direct from the schematic circuit but if you are not an expert there is no need to worry because there really isn't much more to wiring the amplifier than following the connections shown in the wiring diagram.

THE WIRING

The wire may be the ordinary stranded plastic covered type usually used for wiring radio receivers. Two or three feet will be ample, even allowing for some to be wasted in making a few practice joints before you start on the job proper.

The idea is to use just enough heat to ensure a good joint but not enough to soften the insulation seriously. A small electrically heated soldering iron with a fine, well tinned tip is a great help.

If all components are new and not corroded it will be possible to make perfect solder joints using nothing more than the usual radioman's solder wire which includes a core of resin.

At the same time, it is a good idea to have a small supply of paste flux handy for tinning the soldering iron and it may be handy for any joints which are not up to standard at the first try. Don't use more than a trace.

Although not strictly necessary in an amplifier with so few components, it is good practice to cover the bare leads of resistors and capacitors with insulating tubing. Cut the tubing so as to allow about ¼in of bare wire for easy soldering. The same tubing is also valuable if you need to join two wires in order to cover the solder joint.

CARE WITH INSULATION

There is a possibility of sharp edges on the holes for the transformer wires and the power cord cutting through the insulation and therefore we recommend that rubber grommets be installed in these holes. Take great care of the power lead because the energy potential of this circuit is very high and there certainly will be fireworks if a short circuit does take place.

We tied a knot inside the chassis to take the strain of a sudden pull and then soldered the incoming and power transformer leads to a tag strip mounted on the end of the chassis.

In the normal way, the power transformer manufacturers will provide a list of connections. The two thick unstranded wires will be the 6.3V filament winding.

There will be three thinner stranded leads coming out of the same side of the transformer. The two the same color will be the ends of the high tension winding which go to the plates of the 6X4 rectifier while the odd lead will be the centre tap of the same winding and should be connected to earth, that is, the chassis of the amplifier.

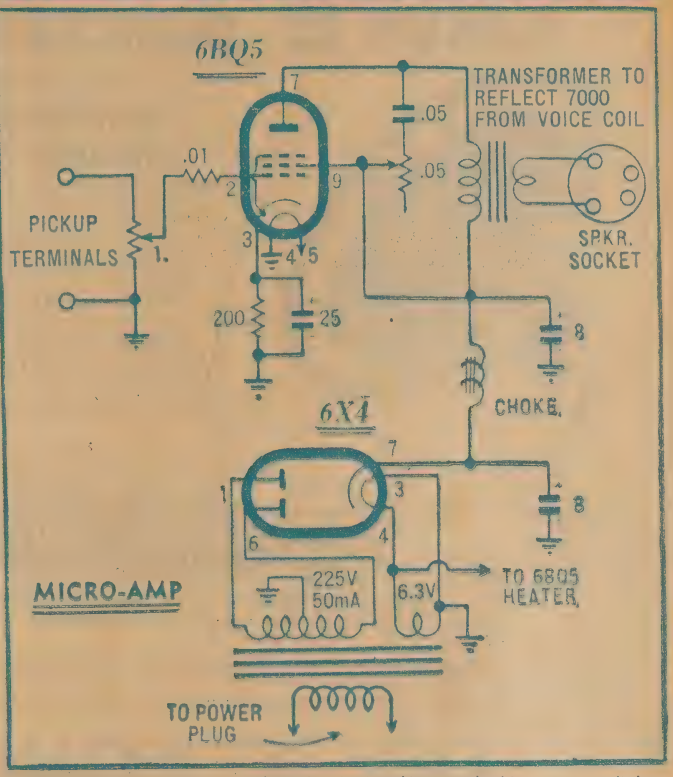
The two remaining leads will be for the 240V primary winding although there may be one additional wire with no insultation or perhaps just a light cotton binding. If so, it will be connected to an electrostatic shield inside the transformer and should be returned to the chassis of the amplifier.

As you will appreciate, the starting point for a discussion of the electrical circuit is the amplifier valve. The rest of the circuit is included only to provide the filament heating and high tension currents for this valve.

We have chosen the 6BQ5, sometimes also known by its European type number EL84, because of its very high power high sensitivity and if you are buying all parts new suggest that you use this valve.

Also suitable and able to be used

AMPLIFIER HAS FEW COMPONENTS



Even if you are not used to schematic circuits this one should cause you little trouble. Note the resistor directly in the grid circuit of the 6BQ5. Its purpose is to prevent unwanted oscillations.

PARTS LIST

- 1 Chassis 6¾in x 2¾in x 1⅞in.
- 1 Power transformer 225V-0-225V at 50mA and 6.3V at 2A secondaries. Primary to suit local mains voltage.
- 1 Speaker transformer, 7000 ohms to voice coil.
- 1 Filter choke, 12H 50mA.
- 1 6BQ5 valve.
- 1 6X4 valve.
- 1 1.0 meg potentiometer.
- 1 0.05 meg potentiometer.
- 1 10,000 ohm, ½ watt resistor (not critical, any value between 5000 and 50,000 ohms is suitable).
- 1 200 ohm, 3 watt resistor (see text).
- 1 25 mfd electrolytic capacitor, 12 volt working or higher (10 mfd or higher may be used).
- 2 8 mfd electrolytic capacitors, 250V working or higher (smallest permissible value).
- 1 .05 mfd paper capacitor, 400V working (.01 mfd may be used but will give less treble cut).
- 1 7-pin miniature valve socket.
- 1 9-pin miniature valve socket.
- 1 4-pin miniature speaker socket.
- 2 Terminals.
- 1 3-lug terminal strip.
- 1 yd hook-up wire.
- 1 Length insulating tubing.

Power flex, power plug, rubber grommets, solder lugs 2 knobs &c.

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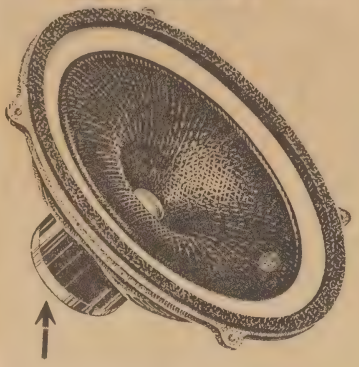

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Cone Resonance (Exponential Cone) . . . app. 35 c.p.s.
Frequency Range . . . 20/17,000 c.p.s.
Flux Density . . . 15,000 lines per sq. cm.
Max. Peak A.C. Input (Open Baffle) . . . 15 Watts.
Voice Coil Diameter . . . 1½".

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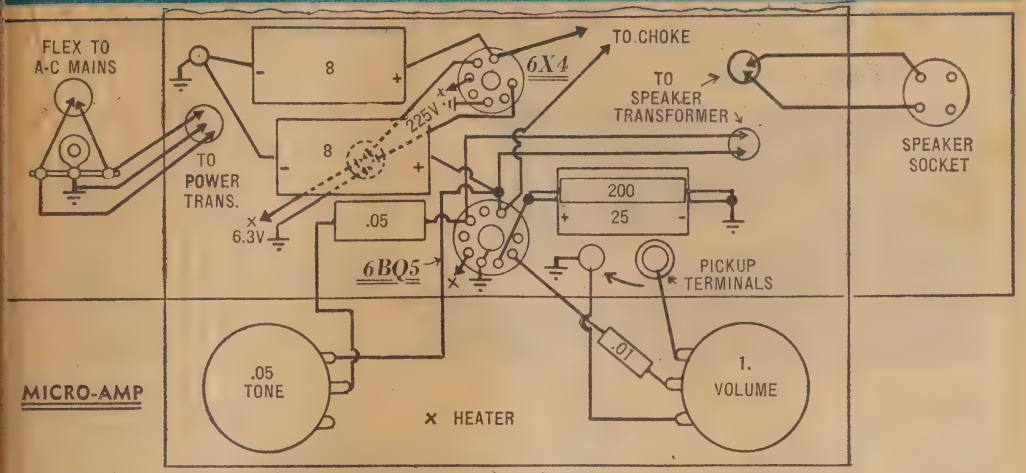


This diagram is virtually to scale and shows every wire in the amplifier. You can mark each wire as it is installed in order to make sure that all have been included.

with very little difference in performance are the 6BV7 and the 6M5.

In the case of the 6BV7 the cathode bias resistor may be any value between 125 and 150 ohms while for the 6M5 we recommend the value be between 175 and 200 ohms. Incidentally, although the value of cathode bias resistor we recommend for the 6BQ5 is 200 ohms anything between 200 and 250 ohms may be used with little change in performance.

Yet another possible valve for the amplifier which we must mention is the 6AQ5. Its power sensitivity is a little lower than the others, but it isn't as bad as all that and if you happen to have one, by all means use it. A 7-pin rather than a 9-pin miniature socket is required and a suitable value of cathode bias resistor in this case is 275 ohms, although anything between 250 ohms and 300 ohms would be perfectly satisfactory, allowing all components to operate within their ratings.

SMALL DIMENSIONS

The power transformer is required to be as compact as possible since it sets the minimum size of the chassis and hence the minimum distance between the bottom of a record player cabinet and the underneath of the motor board in which the amplifier can be mounted. At the same time it should be capable of delivering sufficient power to allow the potentialities of the power amplifier valve to be realised.

The very compact unit we have chosen, now established as a standard line, is rated at 225 volts each side of the centre tap and the direct current drawn from the rectifier may be anything up to 50 mA. At the same time it includes a single 6.3 volt filament winding rated at 3.0 amperes.

Making allowances for practically any rectifier valve used in a capacitor input filter system this is a suitable voltage and sufficient current to permit the full power output of which any of the power amplifier valves just mentioned are capable.

There is only a single filament winding and the rectifier valve filament must be operated from the same winding as the power valve. Two valve types which have especially good insulation between heater and cathode, enabling this to be done and at the same time one side of the filament winding to be earthed, are the 6X4 and the 6V4. In this case, there is really nothing to choose between the two types and, at the toss of a coin, we specified the 6X4.

Following the rectifier valve there is a filter system to smooth the pulsating direct current before it is passed on to the plate and screen of the power valve. It consists of two electrolytic capacitors and an iron cored inductor, usually called a choke.

Having due consideration for cost, general availability and the amount of filtering required to give the desired low level of hum, the electrolytic capacitors have a value of 8 microfarad, while the choke has a nominal inductance rating of 12 henries when filtering the high tension current in this amplifier.

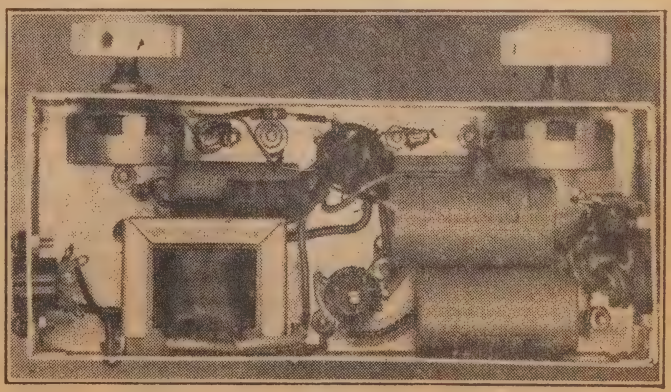
The choke has resistance as well as inductance, but in this amplifier the value is not critical and a choke other than the exact one we used may have any value between 250 ohms and 1000 ohms. Inductance should not be less than 10 henries.

It would not be desirable to use electrolytic capacitors lower in value although, if you happen to come across a pair of 16 microfarad units, small enough to fit in the space, all to the good. In either case the voltage rating should be at least 350 volts.

The loudspeaker and speaker transformer are closely connected and before you buy a speaker transformer, due consideration should be given to the question.

YOUR CHOICE

The speaker depends largely on what you have in mind for housing the amplifier. From the electrical point of view you could use anything from a tiny 3in to a full sized



An underneath photograph of the finished amplifier as constructed in our laboratory. All components are visible.

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2in. The smallest would not reproduce the bass notes fully and would be overloaded with the volume control turned full on while the largest costs more money and takes up considerable space.

Most readers will decide on a 6in or 8in type or perhaps an oval speaker where the available space suits this shape.

The normal arrangement these days is for the speaker and transformer to be sold separately and there are advantages in mounting the transformer on the amplifier chassis rather than the speaker.

Because the function of the transformer is to reflect the loudspeaker load to the valve, the secondary winding must be matched to the speaker voice coil impedance and the primary winding to the valve. The latter works best with a load of about 7000 ohms but, with the various popular speakers, the voice coil impedance may be anything between about 2 ohms and 12 ohms.

So long as the valve ultimately works into a load of between 5000 ohms and 10,000 ohms everything will be in order and the main thing to consider is the ratio of the transformer. If, for example, your transformer is designed to reflect 5000 ohms from a 2 ohm voice coil and you use it with a 2.3 ohm voice coil speaker, the actual load presented to the valve will be, by simple proportion, 5750 ohms, which would be quite in order.

SPEAKER TRANSFORMER

The transformer shown in the photograph happens to be a Jensen "A" type in a sealed can. Both the Rola "G" and the Rola "D" types will fit on the chassis, the latter having the advantage of larger size. There are plenty of other types without the sealed can construction which would also be suitable.

A few thoughts on the subject of mounting the loudspeaker may be of value to readers who have not had a great deal to do with audio equipment.

First of all, there will be those who will wish to mount the speaker in the same cabinet as the motor and pick-up.

This was done in the Radio and Hobbies "Porta-Player", which appeared in the December 1953 issue, where the speaker was a 5in x 7in elliptical type. It was mounted under the motor board on a special baffle as it since the distance between the bottom of the cabinet and the underneath of the motor board was only if the baffle had to be at an angle of approx. 30 degrees.

AIR PATH

If you decide to try something similar be sure to make the minimum air path around the baffle between the front of the cone and the back as long as possible, otherwise the low notes will not be radiated effectively. This may involve an additional baffling partition if you decide to mount the speaker off vertical under the motor board.

Normally there will be an air path from the chamber under the board to the space between the turntable and the lid so that the tonal quality will be affected by the position of the lid and, depending on the cone resonance of the speaker and other factors, you may prefer to have the lid either

(Continued on Page 127)

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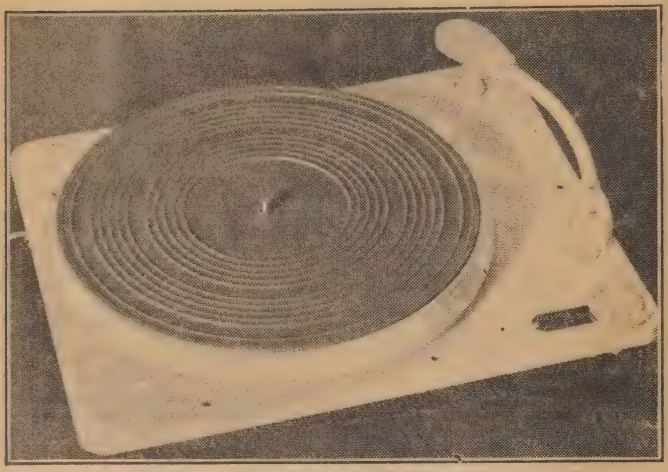


The Collaro Transcription turntable type 2010.

NEW stocks have arrived of the Collaro Model 2010 transcription turntable and pick-up, a high quality job which is suitable either for professional use or for high quality domestic systems.

A feature of the design is a non-magnetic cast turntable which weighs over 8lb and which runs in a precision bearing supported on a thrust ball.

Great care has been taken to obtain good motor balance, so that, as a result, motor rumble is kept to an extremely low figure essential for high grade work.

An idle position is provided between the various speed settings to avoid pressure flats being produced on the idler pulley.

The pick-up supplied is the Collaro Studio type "P", which must be classed among the highest grade crystal pick-ups of the day.

NEW HIGH-OUTPUT ACOS CRYSTAL

A new addition to the Acos range is the type GP59-3 turnover crystal cartridge intended for use where high output is a first consideration.

THE response is not flat, but it i reasonably smooth and shows good wave-form, the result of special method of independen

The Acos GP59-3 cartridge.

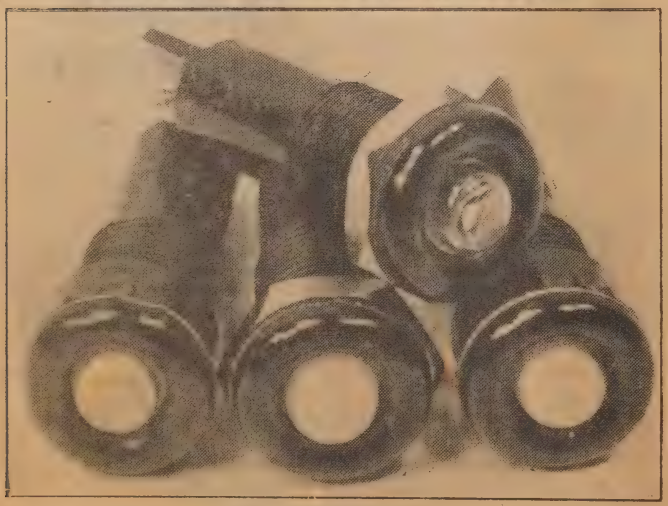
stylus mounting which damps ou resonances and allows easy replace ment.

The output is amazingly high, an is given as 4 volt average at 1 K on 78 records, and 1 volt for LP.

This is more than enough to loa a medium-sized speaker through single valve of the high sensitivit type.

The cartridge will therefore fin many applications in the simple type of record players.

LUMOLITE INDICATORS IN COLORS



A group of Lumolite indicators.

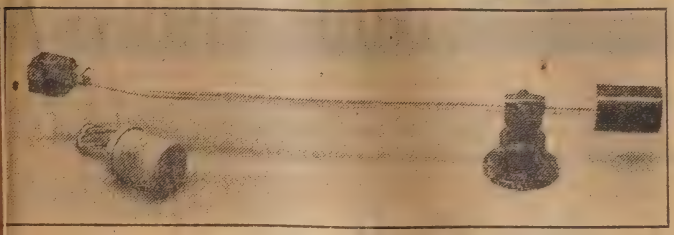
The PL2 Lumolite indicator which has become a popular unit is now available in three additional colors—Green, Blue and Yellow. Voltages are 240 and 415 AC and 220 DC. The price remains at 13/2d.

THE PL2 Neon Indicator, an ide pilot light assembly for use all panels either of metal or in sulating materials, is entirely Australian manufacture, and h been tested and approved by th Sydney County Council.

The indicator incorporates specially designed neon lamp of lo current consumption. The neon tub has extremely long life, gives bright light and the tube itself fitted with a bulls-eye end.

The plastic housing is in the for of a tube fitted with a front bez The body is threaded with 3in 16 turns-per-inch conduit thread A lock nut and washer are provide for mounting the PL2. An insula ing barrier is provided between th terminals so that the insulation be tween terminals is suitable for u on 415V.

ORTOFON HIGH-GRADE PICKUPS



The Ortofon professional pick-up with transformer

The Danish-made Ortofon pick-ups, represented in Australia by Simon Gray, of 28 Elizabeth St., Melbourne, are moving coil types of exceptionally high quality. The laboratory and professional pick-ups are probably not excelled by any others available at the present time.

THE professional type shown here has a beautifully built arm mounted on a base with a double ball-race and adjustable counterweight. That portion of the arm which supports the counterweight has an in-built compliance, and for use with laboratory-type heads, a graduated weight scale.

The heads are a push-fit into a spring-loaded socket, and are locked in place by the half-turn of a ring.

The moving coil movement is precision-built like that of a d'Arsonval meter, and its movement in the magnetic gap controlled within fine limits.

The diamond stylus is carried on a small cantilever arm which provides adequate vertical compliance. The performance of the pick-up in this regard is such that virtually no acoustical noise is produced even on heavily cut discs.

The frequency response of the pick-up is flat to about 13 Kc, after which a rise on open circuit occurs to a peak of about 20 Kc for the LP head. This is controllable by suitable stylus pressure and external loading of the transformer.

Under these conditions the output is very smooth over the working range, and the wave-form as viewed on an oscillograph is completely clean.

LOW DISTORTION

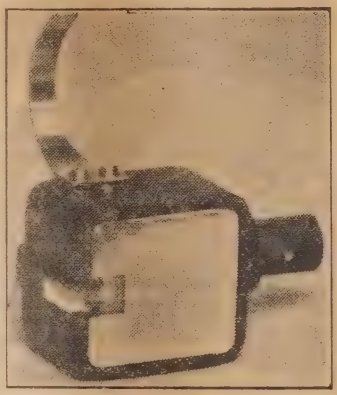
The distortion claimed for this pick-up at high amplitude on a 78 disc is less than .2 pc, largely due to the freedom from pinch effect distortion. This figure is many times less than might be expected from the disc itself.

On test, the Ortofon was quite outstanding, not only for its extreme clarity of reproduction, but for its ability to play heavily-cut, wide-range records with markedly lower distortion.

The laboratory model, which is a variation of the professional type, has an equivalent mass at the stylus point of 1 mg and a microgroove pressure of only 3 grams. It can be used for playing back lacquer and wax masters.

The professional type has a stylus mass of 3 mg and plays with a 5 gram stylus pressure. Its performance is otherwise identical and it is obviously more robust, as might be required for broadcast studio use.

Equipment of this quality is expensive. The laboratory pick-up retails at £107 and the professional type for £89/19/-. Trade prices are lower.



An Ortofon head—the stylus tip may be seen at all times through the gap in the moulded head.

There is also a twin-stylus Ortofon for domestic use. It, too, is a moving coil type, supplied with two sapphire points and coupling transformer. It is mounted in a bakelite arm with variable weight adjustment and retails for £15/6/8.

NEW GRAMO MOTOR TESTS WELL

For some time there has been a gap in the gramo-motor field between the lower priced, mass-produced types and the high-priced, precision designs. Something between the two has been looked for particularly by operators of good audio equipment in the home.

THE prime requirements have been smooth and accurate speed, together with freedom from rumble. While suitable for many occasions, the cheaper motors have not proved satisfactory for these more stringent conditions, and the best grade motors have been hard to get and costly.

The Fidel-o-tone turntable has been produced to sell for £22/8/- retail, and our tests indicated that the above requirements have been adequately fulfilled.

It uses a four-pole induction motor of a popular brand, but specially modified and checked to ensure good armature balance.

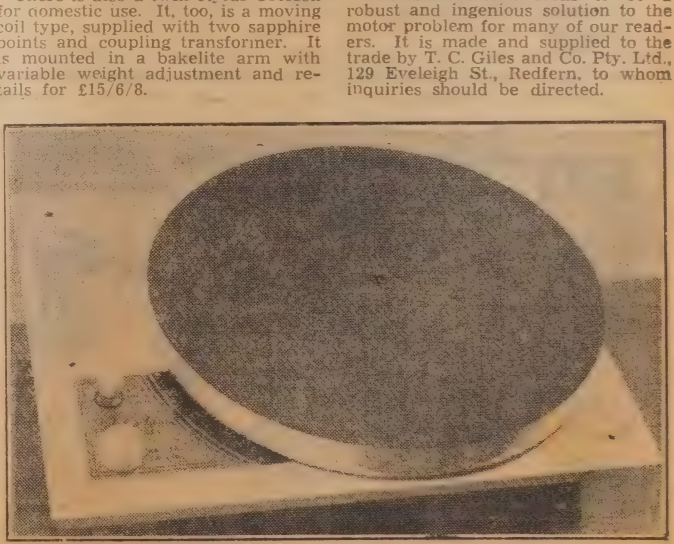
HEAVY TABLE

This is then loosely hung on shock-absorbing mounts, and indirectly coupled to the drive shaft which operates the turntable through a three-speed idler-wheel movement.

The table itself is a heavy non-ferrous cast type which contributes greatly to smooth and even running.

The whole mechanism is mounted on a non-metallic motor board large enough to accommodate all the popular types of pickups.

The Fidel-o-tone looks to be a robust and ingenious solution to the motor problem for many of our readers. It is made and supplied to the trade by T. C. Giles and Co. Pty. Ltd., 129 Eveleigh St., Redfern, to whom inquiries should be directed.



A picture of the Fidel-o-tone gramophone motor.

OFF THE RECORD — NEWS & REVIEWS

The famous Russian violinist, David Oistrakh, has been received overseas with more enthusiasm than has been induced by any artist for years. His first locally produced disc will therefore carry more than usual interest for those who wish to hear how good he is.

by John Moyle

BEETHOVEN — Violin Concerto in D major Opus 61. Played by David Oistrakh and the Stockholm Festival Orchestra conducted by Sixten Ehrling. Columbia 330CX1194.

Without doubt this is wonderful violin playing. Everything you have heard about Oitrakh as a technician is true. No problems are too great for him, his intonation is perfect, his tone is full and consistent from top to bottom.

He is a superlative bowman, and I doubt whether any of his contemporaries can produce such a flawless performance.

But that seems to be the trouble—the whole recording has been made to that end. The violin is so far forward as to overshadow the orchestra completely at times. It sounds very much a studio job in which Oistrakh comes first. In this concerto, above all others, Beethoven must have this honor.

Thus, while admiring to the full the competence of the man wh was playing it, I could not brin myself to believe he understoo very much of it. This is not a tea of players coming to grips with work big enough to exhaust every thing they have to give. Rath is it the spectacle of a master vi linist showing us just how easy can be.

Menuhin can't match Oistrakh a technician, nor is he able to pr duce the broad, flowing lines w hear in this record. But he do achieve a sincerity, an atmosphe of dedication, which Oistrakh h missed.

Mechanically the record is goo It plays cleanly, and the surfa noise is low. The orchestra has rather confined, tubby sound, b the violin, while not brilliant, heard flawlessly. Don't miss hearin it when you get the chance.

WAGNER—Lohengrin with Eleanor Steber (Elsa), Astrid Varnay (Ortrud), and Wolfgang Windgassen (Lohengrin) and the Bayreuth Festival Chorus and Orchestra conducted by Joseph Kilbeth. Recorded at an actual performance in 1953. Columbia LXT2880-4.

If you are a Wagner fan yo will almost certainly have hea this version of Lohengrin broadca from the National stations soon aft the 1953 performance, and will pro ably have a pretty good idea what to expect.

In my view, the big virtue the performance is that it soun alive. That's not surprising, course, but there is an atmosphe about it which no studio perfor ance can produce, or at least ve rarely.

There are a few extraneous st noises, which the purist will pi out with perfect justification, but me they are not objectionable. Th are a kind of aural guarantee th this is the authentic thing, just the movement of people about t stage and the variation in recor ing conditions which result give t impression of a real performan

None of the singers is impeccab vocally, but they are all convin ing, with a kind of dramatic i mediacy which could only happ when playing before an audience.

PRINCE OF "GOODIES"

When referring to convinc characterisation in an opera of kind it is necessary to define o terms, for such conviction is to applied rather to the expression an emotion of the moment than the character as a whole.

What chance has Lohengrin, prince among "goodies", of maki us believe he is a real person, the practicability of magical appe ance in a boat of one swan pow

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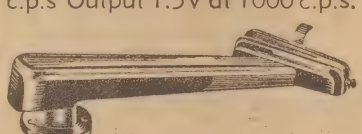

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How can we really get excited about the possibility of the said swan suddenly re-appearing as a handsome youth through the rather involved mechanism that controls the Knights of the Grail?

But if we can overlook the absurdities which have precipitated a dramatic situation, we can applaud the manner in which the actors and singers work it out, a process fundamentally necessary for Wagner lovers.

For this reason I thought Windgassen coped very well with the pallid figures of Lohengrin, although his voice shows a little wear and lacked a certain "ring" which would have invested his part with more vitality.

The other main characters exhibit more human emotions of hate, love, and revenge, and the scheming knight and his wife Ortrud produced some fine drama which the records preserve in splendid fashion.

The orchestra misses the smoothness of an arranged studio setting, but once again it has the sound of the theatre and is remarkably well handled.

I thought this a grand release, and if you agree with me about the value of a live performance I don't think you'll hear a better one. The surfaces of all records are completely silent, and technically there are no embarrassing moments.

DVORAK — Symphony No. 1 in E flat Major; Scherzo Capriccioso Opus 66, played by the Vienna Symphony Orchestra conducted by Henry Swoboda. Westminster WL-5029.

I doubt whether there is another recording of this symphony, which in any case is rarely heard.

The work of Dvorak often shows very clearly the influences of other composers of his day, particularly Wagner and Brahms.

His second symphony is a remarkable example of how well he could write in the fashion of another. And yet he does it so well that we accept it as a lovely work, and in no way a caricature of the original, or a poor imitation.

This first symphony, which although not the first of Dvorak's symphonic compositions is the first to be performed, is almost as clearly Wagnerian as the second was Brahmsian.

But Dvorak's own individuality has not very clearly emerged—he is much more occupied with establishing the manner than in creating the material.

In the second movement, particularly, his pre-occupation with the Wagner is quite remarkable.

As a result, the symphony is rather rambling, with little of a mental core to hold it together. It is extremely pleasant and tuneful, and the Vienna orchestra play it with vigor and brightness. There is no attempt to dig for profundity which isn't there.

The microphone placing it not particularly close, and there is enough reverberation to be noticeable. The net impression is one of liveliness, the orchestra sounds big, and the overall effect is smooth.

Recording amplitude is not high, but the surface is quiet.

MOZART — Symphony No. 25 in G Minor; Symphony No. 38 in D major (Prague) Played by the London Symphony Orchestra conducted by Georg Solti. Decca LXTA2946.

This is an extremely fine record, coupling a musicianly performance with a recording which, although not brilliant in the full sense of the word, has achieved a fine general balance.

Both symphonies are in Mozart's best manner. The beautiful and spirited G minor being composed when he was only 17 years of age. The Prague is a later work and shows more maturity, but both are shot through with imagination and charm.

The orchestra plays with just the right blend of firmness and delicacy. It breathes with vitality and vivacity, and responds to its conductor with the fullest sensitivity. This is Mozart in his own right and stature, and I don't think I have ever heard a recording in which the performers have done such complete justice to this music.

The recording is forward enough to catch the full bite of the performance, with just the right amount of reverberation to bind the orchestra together. It is this completely balanced impression which makes it so good — no single aspect intrudes, all work together to produce wellnigh perfect Mozart.

The surface is a good one, and it plays well with the Decca curve.

BACH—Mass in B minor with Elisabeth Schwarzkopf, Marga Hoffgen, Nicolai Gedda and Heinz Rehfuss, Chorus and Orchestar of the Society and Friends of Music, Vienna, Organ and Harpsichord. Conducted by Herbert von Karajan. Columbia 330CX1121-3.

The Bach Mass represents somewhat specialised listening in the sense that not everyone appreciates this type of music. But those who do, study is deeply and treasure it highly.

For this reason they will probably be more critical than the average, and will want to know before spending their money whether the records are worth while.

Viewed on purely musical grounds, there are no real faults in these discs.

It's true that we can hold discussions about what is or is not "balance" in records which include such a wide range of principals—soloists, choir, orchestra and organ.

There are bound to be places where we think the choir overweights the orchestra, for instance. But it's pretty hopeless to worry too much about whether the oboe is too strong in this bar, or the organ too distant in that.

CONVINCING PERFORMANCE

The truth is that at all times the performance is convincing and beautiful to hear. Some parts of it are good enough to be almost beyond praise.

The reproduction sounds a bit dull, but is well-rounded and with plenty of body. There are noticeable changes in balance from one section to another—inevitable with changed musical combinations. But these are not detractions.

The solo voices are of the highest quality. Heinz Rehfuss exhibits some unsteadiness in his extreme bottom register, but on the whole it

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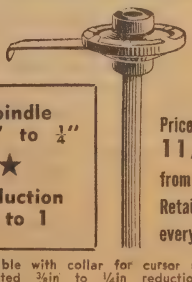

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would be hard to imagine a better team or one more seized with the performance required of them.

Marga Hoffgen I would single out for some particularly fine work, particularly in the Sanctus, perhaps the most impressive section of them all.

And once again this man Karajan merits great commendation for his understanding and control.

A fine issue this, with one of Columbia's best surfaces to date.

BEETHOVEN—Concerto No. 1 in C Major for Piano and Orchestra Opus 15, played by Rudolph Serkin and the Philadelphia Orchestra conducted by Eugene Ormandy. Philips AO1146L.

I thought this record dealt rather severely with what is, after all, a gracious little work, quite happy to sing itself along in the hands of a team which understands it, and is not too preoccupied with its own mannerisms.

The orchestra, a specialist in stating music in extremes, is reasonably subdued, but, aided and abetted by a forward recording, loses no opportunity to underline and dramatise.

Serkin plays throughout with a hard, glassy technique which irons a great deal of the warmth out of his part.

The general tempo is fast, and at times it sounds rather brusque and noisy

It's all too high pressure for me, and applied to a work which doesn't need it.

Otherwise, the record contains much that is good. The sound is rich and full, the recording has plenty of amplitude, and the piano is heard, forcefully and with good authenticity.

The surface is good, and it is a record which should sound well on any machine.

HAYDN—Concerto in D Major Opus 101 for Cello and Orchestra: BOCCHERINI-Concerto in B Flat Major for Cello and Orchestra. Played by Pierre Fournier and the Stuttgart Chamber Orchestra conducted by Karl Munchinger. Decca LXTA2968.

Musically, both these concertos are extremely good.

Fournier's rather romanticised approach gives a welcome and necessary warmth to the music, which sits easily on his shoulders.

There is a subtle difference in the quality of each recording.

The Haydn is extremely forward, so much so that we are conscious of the bow's bite, and a cello tone rather more than life-like.

There is a tendency to record the cello in a close-up to avoid losing it in the orchestra, with which it has a close tonal affinity.

The Boccherini isn't quite so immediate, and I thought the overall balance gained thereby.

But on each side there are some very fine cello sections. Fournier has an occasional intonation lapse, which gives a touch of uncertainty to his work, but this is really a minor point for the record.

Both concertos show good teamwork and are brightly played.

I liked best the final movement of the Haydn, and both slow movements in which the soloist has plenty of scope to show his excellent musicianship.

Two silent surfaces add to the value of a disc which will be welcomed by library builders.

BEETHOVEN—Sonata No. 5 Opus 24 in F Major (Spring); Sonata No. 6 Opus 30, No. 1 in A Major. Played by Nap de Klijn (violin) and Alice Hakesch (piano) (The Amsterdam Duo). Philips AO0234L.

This is a disc right up to Philips' best standard in every respect.

The players have obviously worked together with considerable profit, and have developed into an exceedingly competent team.

Of the two I thought the pianist showed up best. She plays with a fine tone, and, when required, with great strength and authority.

In fact, there are many occasions in which she steals the thunder which should have belonged to the violinist.

He, in turn, has a smooth, consistent tone, but does not always match the enterprise of his partner.

There is a liveliness about the sound which I liked very much, and a nicely controlled reverberation. The microphone placement may be responsible for favoring the pianist, but at any rate it has been chosen to provide a very nice bass, quite free from that tubbiness which often creeps in with such forward recording.

The Spring Sonata is the better known than the Opus 30, from which the original last movement was extracted for use in the Kreutzer Sonata, and a very good thing, too. It sounds much better as it is.

The surface isn't as impeccable as some Philips, but is still low enough to pass without further comment.

On the whole, a delightful disc which will bring you much pleasure.

SCHUBERT—Winteresse, sung by Hans Hotter, baritone, with Gerald Moore accompanist. Columbia 33CXS1222.

It is doubtful whether we will ever hear a better performance of the Winter's Journey, than is contained on these records.

Hans Hotter is the perfect choice. I think a bass or baritone voice best suited to these songs, and a man like Hotter has no need to press the emotional pitch as a lighter-voice is often forced to do.

His very restraint gives added weight to the effectiveness of such moments, in which he is able to command an intensity and power much more effective than the ammunition of the average tenor.

If there is a criticism it is that he unduly limits his emotional range, and that he lacks complete certainty in his lowest vocal register.

Against such things, he brings a perfectly relaxed voice, a remarkable sensitivity and flexibility, and the finest imaginable control. There are countless examples during this long cycle of exquisite artistry.

Gerald Moore, as always, is a superb accompanist. His judgment of the music and the singer are faultless. Together these two have

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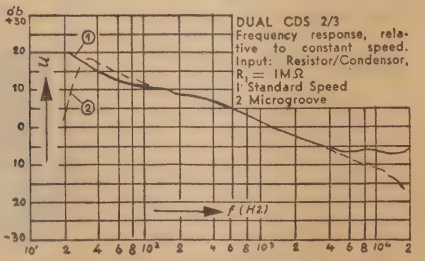

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produced in this work some of the finest examples of lieder in the gramophone catalogue.

The recording is noteworthy mainly for its good balance. I was glad to note that too forward a microphone had not been used.

In one or two of the songs I detected a rather strange blurriness of quality, just enough to register as a mental query. But, otherwise, the pressings are good and the surfaces quiet.

SIBELIUS—Symphony No. 3 in C major, Opus 52; Symphony No. 7 in C major, Opus 105. Decca LXTA2960. Symphony No. 4 in A minor, Opus 63—Pohjola's Daughter, Symphonic Fantasia, Opus 49. Decca LXTA2962. Played by the London Symphony Orchestra, conducted by Anthony Collins.

If you haven't yet examined the claims of Sibelius as a symphonic composer, these records will give you a first-class opportunity. They follow issues of the first and second symphonies already to the credit of this orchestra and conductor.

Like most orchestral composers of note, Sibelius went through his periods. The first and second symphonies, although completely individual in style, contained much more of the romantic brush than do any of these.

The third is the nearest to them in this respect, but in it we can see emerging the Fourth, in which Sibelius deliberately set out to write something utterly different from the conventional symphony.

The result is a work which was the subject of tremendous controversy when first played, although it isn't so strange to our ears today.

As an attempt to present a mental process through the language of music with complete directness and lack of ornament (or the "circus" as Sibelius himself put it), there has never been its equal. It might take some getting used to, but makes no mistake about its importance or its greatness.

The Seventh is often considered as the peak of the composer's orchestral work, and it may well be. It isn't nearly as uncompromising as that of his middle period, but in it will be found the maturity of a remarkable musical career.

Somebody once said that Sibelius, having clarified and crystallised his musical ideas, presented them completely and concisely, and having come to the end, just stopped.

You will have to get used to the idea of just stopping. I often wish he had been a little less brusque in his exits, particularly in the Seventh. There is doubt about it having reached the end, but the curtain drops with a finality just as certain as though the conductor rather than add a superfluous wow or an intrusive flourish, just dropped his baton and disappeared into the folds.

The performances are admirable and I'm sure you will find little to complain about. Collins still shows a tendency to flamboyancy which I find a bit theatrical. The recording is of good standard—it has a touch of hard aloofness about it which I do not find objectionable, although it might not suit everything. Let us say I am still unearthing so much good from both discs that I have not yet bothered to get fussy.

The fill-up with the Fourth symphony is more or less for the record, when compared with the mighty music of the remainder.

MOUSSORGSKY—Pictures at an Exhibition. RAVEL — La Valse. Played by the L'Orchestra de la Societe des Concerts du Consevratoire de Paris, conducted by Ernest Ansermet. Decca LXTA2896.

The Chicago Symphony Orchestra's version of this piece, originally made by Mercury and released here on HMV label, is in my opinion a hot contender for the best disc ever made from a technical viewpoint.

Not long ago Philips issued one here which was very nearly as good. Actually there are a number of versions, all made obviously with the idea of competing with Mercury.

Ansermet might never have heard of these super-brilliant predecessors, as we hear him in this record.

Not that there isn't fine, vivid recording, for there certainly is. But Ansermet has set out to play the music, and not the gallery. His tempos throughout are much steadier, his breaks between sections are quite noticeable, and as a matter of fact a little irritating, no matter how authentic they may be.

At the same time, on the grounds of musical presentation, and not sheer power, I might well choose this disc in preference to them all.

The orchestra isn't as forward as some others, but there is magic in the delicacy and clarity so often achieved, with no lack of weight or impact when required.

The dynamic range isn't as great as the Chicago orchestra achieves, but the frequency range is quite as wide, and maybe even wider.

The surface noise is non-existent.

Don't let anything put you off hearing this disc if you are in the market for the "Pictures".

La Valse is presented in Ansermet's sensitive, meticulous style, and has the same quality of recording as the "Pictures". It's a nebulous, fascinating thing, presumably bent on avoiding any kind of a mental conclusion. Maybe in that lies its greatest charm.

GRIEG—Piano Concerto in A minor, Opus 16. Played by Dinu Lipatti and the Philharmonia Orchestra, conducted by Alceo Galliera. Columbia 33OC1040.

Lipatti's version of this concerto is quite a sensation in the dying days of the 78 record, and many will have been waiting for this representation on LP.

The process of re-recording isn't always successful, but here there is certainly nothing lost if little gained. It isn't as vivid or immediate as one would expect of a present day part, but it is still very good.

The performance undoubtedly is a beautiful one. I think it will hold a permanent place of its own, no matter what other versions might appear.

Lipatti's rare combination of strength, technical competence, and warm, romantic feeling are just right for this concerto, so often exploited by amateurs, or discounted by the great with a kindly tolerance.

Lipatti convinces us that it is a fine and important work, and so it is.

We can all be happy that the LP recovery has been so successful. Wide range machines will pick a slight surface rustle which changes with the 78 sides, and may also comment on the rather dull frequency range. But these are far less noticeable than one would expect.

TCHAIKOWSKY — Romeo and Juliet Overture, played by the Concertgebouw Orchestra of Amsterdam conducted by Paul van Kempen. Philips SO6O29R.

As a performance this is quite good and quite straightforward. It hasn't the extremes of tempo we find in Scherchen's version for Nixa, nor the wild urgency of Cantelli's HMV version, which on the whole I would choose as the best.

The Philips disc has rather a pronounced reverberation, and an orchestral placement which tends to bring the strings forward, but to lose a good deal of the rest in the echo.

The impact of the mighty clashes is as vivid here as on either of the others mentioned, although Cantelli's has the greater mass of sound, and by far the greater excitement.

The Philips has the added disadvantage of a turnover, whereas the others are complete on one side. On the other hand it is a 10-inch disc as against 12 inchers.

BEETHOVEN—Concerto No. 4 in G Major Opus 58. Played by Clifford Curzon and the Vienna Philharmonic Orchestra, conducted by Hans Knappertsbusch. Decca LXTA2948.

Your reaction to this record will depend on your ideas of how the concerto should be played.

If you are looking for a bold, round and full approach, with that touch of the heroic, which is demanded even by Beethoven's less heroic works, then you'll look elsewhere.

Let's face it—Curzon isn't a heroic pianist. Even when he goes through the actions he doesn't get away with it.

In this concerto, and particularly in the first movement, his careful, fastidious, and tentative outlook appears in every note.

The orchestra takes its cue from him, and for the most part trails along in his wake. When the pianist is silent, you can almost hear it breaking out with a new freedom, only to come back to heel when the piano re-enters.

Perhaps my reaction overstates the case, but this fiddly approach always annoys me.

I would much rather have Solomon's effort on a 10-inch HMV, which, if it had been a little bigger all round, might well have been a world beater.

As it is, Solomon has succeeded in producing tone which Curzon probably aimed at but missed. Solomon, too, has the surer touch and feeling for the work. The first few bars will tell you that.

However, there is great sincerity in Curzon's performance, and much of it sounds very well. The recording, too, passes with good marks, and the surface is quiet.

Maybe this is another you had better hear for yourself.

SCHUBERT—Valse Caprice, Entracte and Ballet Music from Rosamunde, Two Galops, Marche Militaire, Rondo, Ave Maria and Marche Characteristique. Played by the Westminster Light Orchestra conducted by Leslie Bridgewater. WL4006.

Everyone will like this record, containing as it does some of Schubert's best tunes, and they don't come much better.

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Leslie Bridgewater is a special- t in light orchestras. Nearly eryone has heard of him, and lis- ned to his work through a long sociation with the BBC.

The playing is bright and the cording is vivid and with plenty range. I don't think it's up to estminster's very best, and there a trace of surface noise on side But only wide range machines e likely to notice it.

HRISTMAS MUSIC

The ABC Adelaide Chorus pre- nts some Christmas music for e month, in the form of a Co- mbia 10-inch containing nine ustralian Christmas carols compos- by W. G. James. The chorus nducted by Norman Chinner, ngs exceedingly well, and the gen- al quality is very similar to that ard on a good broadcast from their me city. The children know arly all these carols.

On Decca LFA1149 Mantovani d his orchestra play two sides carols—all the well-known ones and his treatment of them is much re successful than you might nk. There are 10 numbers in , and the recording is good.

DME 45'S

So many major releases come out ese days that the 45's aren't ely mentioned in these columns. me of them which have caught ear recently include a couple m Radiola, who will soon be sing the big field in a big way. ey are Intermezzo from Pagliacci Cavalleria Rusticana played by Hamburg Philharmonic Orches- on U-45682, and on U-45861, by the same orchestra, the In- mezzi from Thousand and One hts by Strauss, with Hellmesber- 's Devil Dance on the reverse.

Beautiful singing by Renata Teb- i for Decca is on 45-X102 with Quelle Trine Morbide from Manon caut, and Tacea La Notte Pla- a from Tosca. Kathleen Ferrier's rless contralto is heard as a con- t in Ca' The Yowes and O Waly ly on Decca 45-X101. It plays nly for me.

sample of the full Tosca re- e by Columbia soon to come is n on SELO1526. Maria Mene- hi Callas, Melchiorre Luise, and seppi di Stefano sing E Sempre a, Recondite Armonia, and Vissi rte with the La Scala Orches- It's first class.

he Vienna Philharmonic under Karajan play two Strauss zes most effectively—Transac- s Waltz and Music of the Spheres Columbia SELO1505, while the e Orchestra conducted by Bar- li provide contrasts with Chab- s Espana-Rhapsody and The anted Lake by Liadov for HMV ERO5026.

vo more good HMV's are by ria de los Angeles singing Una Poco Fa and Contro Un Cor Accende Amore from the Bar- of Seville, accompanied by the n Symphony Orchestra— O5038 and the Vienna Phil- nonic Orchestra conducted by wangler in the Fidelio overture Wagner's Tristan Prelude on reverse. 7ERO—5036.

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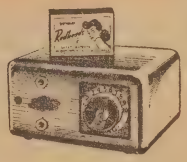

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PRICE'S RADIO

5-6 ANGEL PLACE, SYDNEY

SHORT-WAVE NOTES BY ART CUSHEN

EARLY RISERS WELL REWARDED

An early rise at dawn by our readers will be well rewarded with many interesting signals on 60 and 90 metres.

KEMPALA, Uganda, operating on 5027 Kc is the latest new country to be logged in this area, and has been heard with fair signals.

At 4 am they carry the BBC news, while at 4.15 am a further BBC news commentary or like program is relayed with the sign-off at 4.30 am with the National Anthem.

The Kempala station uses 7500 watts and is operated by the Uganda Broadcasting Service. Chief Engineer is Mr. Graham Phillips, formerly of the BBC, and the station has been in service for slightly over a year.

The Marconi transmitter has only been on a few months. Formerly the station, since commencement used lower power than 7500 watts. They use a vertical incidence type antenna which does not favor distant reception, but, even so, signals have been heard consistently.

NIGERIA

Lagos using 4800 Kc has also a BBC news relay at 4.00 am which at 4.10 am is generally followed by a local news broadcast. Signals are fair for this 20Kw transmitter, and though the station fades out at 5 am here it should be possible to hear the broadcasts for a longer period in Australia. Kaduna station of the Nigerian Broadcasting Service on 3326 Kc has been logged by Len Collett at 5 am with weak signals.

KENYA

Nairobi using 4885 Kc is one of the best signals and carries a complete transmission in English, with BBC news at 4.00 am and at 4.10 am local news, while plays or classical musical programs make up the balance of the transmissions generally.

East African Broadcasting Service which has a broadcast in Swahili to 4.00 am on Mondays operates on 4934 Kc, while the Forces Broadcasting station at Nairobi, though not reported, should also be a possibility on 5034 Kc to sign off at 6.00 am. The nearby Tanganyika transmitter on 5050 Kc was fully covered in last issue and has been heard to closing at 5.20 am or later.

LIBERIA

The Missionary station in Monrovia, Liberia, has been reported on 4835 Kc from 6.15 am to fade out at 7.10 am, while transmissions are still reported to be carried on 11805 Kc.

Other signals being reported include the Persian Gulf transmitter on Kuwait, using 5000 Kc and heard generally at good strength in Arabic at 5.00 am.

Len Collett of Oamaru, NZ, informs us that on the 90 M band he is hearing the Federal Broadcasting Service at Salisbury, Southern Rhodesia, with poor to fair signals from 4.30 to 5.30 am on 3396 Kc, Loureneo Marques on 3215 Kc fair to good with English to sign off 5.30 am, while Radio Dakar, Senegal, generally can be heard through morse on 4893 Kc at 5 am most mornings.

SPECIAL BROADCAST FROM HILVERSUM

On January 17th, 1956, from 7.45pm Radio Nederlands at Hilversum will broadcast a special programme to celebrate the Centennial of the Province of Southland and its Capital city of Invercargill. The broadcast will include greetings from the Mayor of Hilversum, an executive of Radio Nederlands and two parents of Dutch folk living in Southland. The frequencies of 17775Kc and 15220Kc will be used, and the broadcast, being in English, will replace the usual Tuesday feature "By Request". Reports from listeners hearing the broadcast would be appeciated by E. L. Van Dulken, Head of the English section, PO Box 137, Hilversum, Netherlands.

Army broadcasting

A TEST transmission on 7850 Kc using the low power of 25 watt has been heard on Tuesdays between 7.00 and 9.00 pm, in a transmission which usually lasts an hour.

First reported by Melbourne listeners, the station has been heard in New Zealand at surprising good strength for 25 watts. Identification is given as "This is Radio Puckapunyal" and is under the control of the Southern Command of the Australian Army.

The program has consisted of a studio performance of "Twenty Questions" at 8 pm which has been followed at 8.30 pm by microgroove recordings to sign off at 9.00 pm when the station slogan and frequency are given. Reports for the station should be sent to Mr. Graham Hutchins, DX Editor, Radio Australia, Box 780H, Melbourne who will see that your report is passed on to the right authorities.

It is over 10 years since the last Australian Army station was heard here, and at that time the transmitters were operated by the Australian Army Amenities Service, and when making air tests at Williamstown, Melbourne. These tests were with 200 watts and generally conducted on 1460 Kc, before the station was shipped to the forward areas, when in 1945 a network of some 21 stations were in operation for the entertainment of Australian Forces.

CKNK WITHDRAWN

THE International Service of the Canadian Broadcasting Corporation has withdrawn the new CKNK transmitter using 11945 Kc. This transmitter beamed to the North West Territories, and suffered severe jamming here.

In a recent letter the Supervisor of Engineering Services, stated that reports on the frequency from listeners had been of great help but as some trouble was experienced with dual frequency arrays the transmitter on this channel has to be dropped. The channel was a little too far from the frequencies normally employed, but this condition of the aerial tuning is being rectified and they may use CKNK again at a later date.

NEW EABS NAIROBI

THE East African Broadcasting Service, which has the mailing address of PO Box 1525 and operated by the Kenya Department of Information is a new broadcasting station. World Radio Handbook states this station operates a 6000 watt transmitter on 4934 Kc. The operating schedule is week days 1.30-2.30 pm, 8.00-9.00 pm in Swahili, 10.45-11.00 pm (Luluvka), 11.00-11.15 (Lou), 11.15-11.30 (Nandi-Kipsigis), 11.30-11.45 (Kikamba), 11.45-midnight (Kikuyu), midnight 3 am (Swahili). Sunday 4.00-8.00 pm and 12.30-4.00 am (Swahili).

RADIO NEDERLANDS IN 10th ANNIVERSARY

Broadcasts which first commenced 13th October, 1945, with a staff of six h resulted in what we now know as Rad Nederlands, Hilversum, which recen celebrated its 10th anniversary, repo the Dutch program bulletin.

Broadcasts from 1945 were not the fi made from Holland. Prewar shortwa listeners will recall that in 1927 t Philips Radio works at Eindhoven broa cast to the then Dutch East Indies, so 7000 miles, using the callsign PCJJ a later PCJ. One of the earlier progran "The Happy Station", still continues und the genial announcer Eddy Startz. PC rotary antenna system erected in t late 1930's provoked interest in the no system, slung between two towers mou ed on a round track, and rotated by r mote control.

During the War the BBC offered its se vices to Dutchmen in other lands a in occupied Europe the broadcasts fr London of Radio Orange became the li between them and the Government exile. In 1945 came Liberation and t

All times are in Eastern Australian. Notes should be sent to Arthur. T. Cushen, 212 Earn Street, Invercargill, NZ.

new Radio Nederlands. No longer private enterprise but controlled by board, with Government backing transmitter power and schedules wi increased, and the staff now totals o 200.

The year 1956 will see increased pow Radio Nederlands realises that th contact with listeners is often thwar by poor reception, as a result of w transmitters.

An all out effort is being made remedy this unfortunate situation. A r station is being built at Lopik, Utre and in 1956 they hope to have in ra succession three transmitters of 100 each in operation.

They therefore attach special signi ance to the 10th anniversary, not beca 10 years is such a great deal in a time, let alone measured by the ye stick of history, but is a significant in the new International Service of R Nederlands.

FLASHES FROM EVERYWHERE

JAPAN'S 300 watt relay stations w have been reported before in these pa as being used for relay points du certain periods in the 90 metre b have been heard again over the past weeks with an additional transmitter 3970 Kc. The station located in Tokio the call sign JKA-20 and is heard at strength at 8 pm.

The transmissions are those of normal NHK first network and at 8 the time signal and NHK identificatio given. The station signs off at 12.30 but being a relay of the key Tokio st JOAK no call sign, other than the station is broadcast.

COLOGNE has altered the times o transmissions to the Far East which covers reception in this area, and service carried on 15275, 11795 and 97 now opens at 8 pm instead of 8.30 p formerly.

Sign off is now 11 pm. The other t missions from Deutsche Welle, are 3.30 am on 17845, 11945, 9649 Kc to East, 4.00-7.00 am on 11795, 9640, 71 Africa, 8.00-11.00 am on 11795, 9640, to South America, and 11.30 am-2.30 on 9640, 7205 and 5980 Kc to America.

THE HAM BANDS WITH BILL MOORE

Amateur television transmission will soon be permitted in Australia. Undoubtedly radio amateurs here will follow the lead of British and American amateurs who have carried out extensive experiments in this field.

THE Press statement released in Canberra on October 25 by the Postmaster-General, Mr. Anthony, confirmed that Radio Amateurs would be permitted to experiment with television. Transmissions will be allowed on their UHF bands with an input of 100 watts.

The final arrangements for transmission will be made after discussions between the PMG's Department, the Australian Broadcasting Board and the Wireless Institute of Australia.

The Postmaster-General announced permission had been granted after representations had been made on behalf of the A stralian Amateur by the Federal Executive of the Wireless Institute of Australia.

With TV promised for next ye r in Australia the remarks of US FCC Commissioner George E. Sterling made some years ago at a TV industry meeting at Cleveland on TV receiver interference are worth repeating.

The Commissioner pointed out that the FCC was fully aware of inadequacy of design and construction of many TV receivers, and discussed the many forms of interference caused by their poor design.

ORM FROM RECEIVERS

After discussing problems of oscillator adiation the Commissioner continued, Radiation of harmonics and hash from V receivers interferes with airports, ommercial circuits, and the amateur ser- ice and sometimes even broadcast ser- ice. Tune across the standard broadcast and some time and listen to the "beeps" nd "hash" from your own or neighbor's V receivers.

One of the greater contributions to he art and industry during the past wo years in the suppression of radiation y filtering and shielding has been made y the amateurs as they sought ways nd means of operating their transmitters ithout causing interference to TV reception.

Several years ago the Commission determined that the operation of the mateur service was in the public interest.

It was only last week that the Commission in collaboration with the Director f Civilian Defence and the Military rovided an allocation of frequencies for se by the amateurs for Civil Defence.

If your city or any other city in he country were attacked tonight and ommunication were disrupted, the mateur service would be the first to provide emergency communication as they have done throughout the nation for years in time of floods, hurricanes and other disasters.

Their frequencies and the frequencies of other services must be kept free of the "hash" and other emissions radiated by poorly shielded and filtered TV receivers.

If the above is not done Commissioner Sterling indicated it may be necessary for FCC to "take drastic action."

Undoubtedly in the intervening few years some of the problems of TVI in reverse have been cured. It can only be hoped that manufacturers here pay due attention to receiver interference.

In Great Britain the Postmaster-General, the Rt. Hon. Dr. Charles Hill, MP, recently presided at a Press conference when the implications of the new regulations dealing with radio interference were discussed. These regulations as mentioned previously covered interference from small electric motors under 1hp.

The PMG discussed interference from television receivers and made it clear whilst the GPO had no power to make regulations about interference from such receivers it would take action in some cases.

If a person has a set which is causing interference and refuses to take reasonable steps to suppress it, his licence will be withdrawn.

NSW LECTURE

The inaugural lecture presented to members of the NSW TVI and BCI committee was well received, 27 members attending.

Norm Beard, VK2ALJ, lectured on TVI receivers generally and will expand on the subject in future discussions. It is intended to present a thorough insight into receiver operation and so give members every opportunity to understand TVI problems that are likely to arise.

The voluntary work of the lecturer, of Max Sobels, VK2OT, and Mr. Mondel, all of the NSW Technical Education Department is invaluable.

The committee greatly appreciates their untiring efforts to ensure the success of the project on BCI and TVI cures.

Some vacancies occur on the committee for amateurs who will be trained to assist on cures for and liaison on TVI problems.

The chairman of the committee, Dr. Bob Black, VK2QZ, can be contacted at the Division's, Box No. 1734, GPO, Sydney, or at his home QTH.

EMERGENCY NET OPERATES AGAIN

THE NSW WIA Division's amateur emergency net again swung into action during the floods in late October. VK2WI opened officially on October 25 at the request of the NSW State Emergency Co-ordinator.

On the previous evening stations in areas likely to be affected arranged to be on schedule at 0700 hours. It was the first occasion that the net had operated officially as a part of the NSW Emergency service.

At this stage serious flooding was anticipated in western NSW along the Peel, Namoi, Macquarie and Lachlan Rivers.

Fortunately rain in the higher reaches of these rivers abated and although the outskirts of several towns were flooded, damage was small as compared with previous disasters.

The net operated from October 25 for four days. Considerable traffic was handled on the first days and gradually tapered off as the floods were followed down the various rivers. Traffic was handled to and from the State Emergency HQ in Sydney.

Main centres covered were Narrabri where Hart Wall, VK2JC, and Chic Macartney, VK2DK, operated. They were also in communication with the B/c station at Gunnedah.

Hugo Stitt, VK2WH, and John Meagher, VK2AMV, were active from Forbes on the Lachlan, while Frank Taylor, VK2APF, covered Tamworth and surrounding districts. Many other amateurs from nearby districts reported into the Net. All the above districts were affected by flood waters.

At no stage did normal telegraphic services fail so traffic was limited, but it was a valuable trial run under the new State wide organisation.

VK2WI was mainly operated by President Jim Corbin, VK2YC, ably assisted by his wife and they spent a very busy first day. A number of other stations also acted as control stations.

With so many areas in NSW vulnerable to flooding, the Net will be called upon on many occasions to afford emergency communication.

NEWS FROM W. AUSTRALIA

THE October meeting of the WA VHF group was held at Ron Mould, VK6FM's home and three new members were welcomed, Alf, VK6EA and Tom, VK6ZAF also George from Mundaring.

The group was pleased to receive letters from the New South Wales and New Guinea VHF groups supporting their efforts to have the changes to the 50 and 144 mc/s bands reconsidered. It also appears support will be forthcoming from other States.

Barry Goodman, VK2ZAG, of Sydney was the lecturer and he gave an account of VHF activity in Sydney and his efforts on 1215 mc/s. The fact that the meeting did not close until 12.30 am was indicative of the interest in the lecture.

Activity on the bands has been quiet due mainly to approaching examinations amongst the younger members. However, a great deal of interest was caused by a mobile run of VK6ZAA with seven members of the Modern Radio School and Hi-Fi Club.

The students much appreciated this trip and the visit to some of the shacks, thanks to Don VK6HK, Don VK6ZAV, Ralph VK6ZAD, and Murray VK6ZAM.

FOX HUNT

The inaugural fox hunt of the group will be held on December 17. Invitations have been sent to members of the WIA and Radio Society. The main requirements are a receiver, car and some sort of a beam. The trasmitter will operate on 144 mc and possibly 50 mc/s too. Cars should assemble in Kings Park at 8.00 pm.

Apropos call sign number plates mentioned in the October issue, the ultimate in NSW anyway is that of Max Moore, VK211's, plate VK211, the "double one" an exact replica of the final letters in Max's call. Peter Alexander, VK2PA, pointed out this effort.

Dick Hawkings, VS4BA, has been creating some interest on 14 mc/s and is active most evenings from Kuching Sarawak.

He generally opens around 2000 hours EAST. QSL's should be forwarded direct to the post office, Kuching.

The current VKI gang on Macquarie Island will be back in Melbourne in mid-December.

VKIZM has been very active from the island with 25 watts to two elements on 14 mc. His colleague VKIDC has been operating also.

Active from Mawson, Antartica, is VK1AWI who is at good strength most evenings, but to date has been heard mainly on schedule with VKIAHH on Heard Island.

ROSS HULL CONTEST

THE Wireless Institute of Australia's Annual VHF contest for the Ross A. Hull Memorial Trophy will be held in December and January. The contest has been extended this year to cover the 50, 56, 144 and 288 mc/s bands. In previous years operation was restricted to the 50 mc band only.

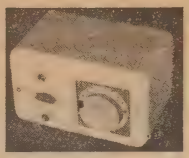
The following is a summary of the main rules:—

The contest commences at 0001 EAST on December 1 and concludes at 2359 EAST on January 31.

Interstate, intrastate and overseas contacts are allowed.

Cross-band working is not allowed. LAOCY licencees are encouraged to work on the 144 and 288 mc bands.

MOTOR SPARES LTD



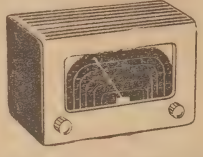
Q-PLUS CRYSTAL SETS

Dimensions 5ins x 3ins x 3ins. Cabinet is made from Cream Plastic, fixed crystal detector. Very easily operated. **Price less headphones, 49/6**

High Impedance headphones to suit, 39/6 pair.

Parts for Crystal Sets.

Single Gang Condensers, .. **9/6 each**
Buron Crystal Set Coils with Circuit included .. .. **6/3 each**
Germanium Diodes .. .. .. **4/3 each**
Nickel Plated Screw Terminals, **9d each**
100 ft. Coils Aerial Wire .. .. **5/- each**
Porcelain Egg Insulators .. .. **9d each**



ONE-VALVE KIT SET

For the Learner.

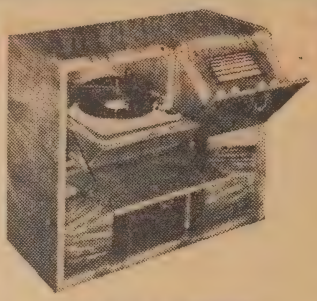
Although this little set is quickly and simply built, it looks like a factory built job. The wooden cabinet is covered with Burgundy Leatherette, and the Dial has all Australian Stations marked in different colours. Parts are mounted on a wooden Base-Board and anyone can build it if they can use a soldering iron. Circuit Diagrams, wire, solder, etc., supplied. Price for complete Kit of Parts, including Valve, Headphones and Batteries, at normal price is £8/5/-.

Our Price £5/19/6

CATHODE RAY TUBES

all in perfect condition.

5BP1, 5 inch **39/6**
VCR97, 6 inch **39/6**
VCR522, 12 inch **25/-**
VCR138, 3½ inch **32/6**
AV11 High Voltage Rectifiers **8/9**
954 Valves **5/6**
958A Valves **4/6**
1P5G **7/6**

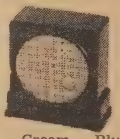


RADIO CABINETS

As illustrated. Latest type with slide-out changer panel and tip-out radio set, panel fitted with Velvet Action door closer. Record storage cupboard. Overall size 35ins Long, 31ins High, 16ins Deep. Set panel 16 x 8. Baffle cut for 12 inch Speaker. Changer and Set panels uncut. Colours available: Walnut, Mahogany, and Blonde.

Price only £22/10/-

CHIEFTAIN EXTENSION SPEAKERS



All colors available, Cream, Blue, Green, Grey, Walnut, Burgundy, with 3 inch Speaker fitted. **Our price, 35/-** each.

Walnut Cabinets only .. .. **5/-** each

SPECIALS

1. **Block Condensers,** .1+.1, 1500 Volt Test. Brand New German Make, **6d each.**
2. Block Condensers, .25, 1500 Volt Test. As above. **6d each.**
3. Block Condensers, .5, 2000 Volt Test. **9d each.**
4. Block Condensers, 4mfd, 750 Volt Wkg. Brand new and perfect, **5/9 each.**
5. Block Condensers, 4mfd, 500 Volt Wkg. **5/- each.**
6. EF 50 Valve Sockets. Ceramic low loss insulation with earthing plate. **3/9 each.**
7. 8 Pin Jones Plugs and Sockets. In good condition. **5/9 pair.**
8. 12 Pin Jones Plugs and Sockets. **8/6 pair.**
9. Power Transformers. Primary 240 Volts. Secondary 210 Volts Aside at 40ma. Filaments 5 Volts and 6.3 Volts. Flat Mounting. Brand new. Worth 55/-. **Only 19/6 each.**
10. Few only, 60ma Power Transformers, 285 Aside 6.3 and 5 Volt Filaments. **Only 25/- each.**
11. Vibrator Transformers, 6 Volt to 135 Volts at 15ma. Ideal for Vibrator Receivers using 2 Volt or 1.5 Volt Tubes. Worth 49/6. **Only 14/6 each.**
12. Special Tape Recorder Transformers. Low Radiation Type eliminates hum. These Transformers are worth £4. **Our price 39/6 each.**
13. Audio Transformers, 3-1 ratio class A. Worth 27/6. **Our price, 9/6 each.**
14. Push Pull Audio Transformers, 3-1 ratio class A. Worth 29/6. **Our price, 11/6 each.**
15. Filter Chokes, 75ma, 50 henry 450 ohms DC resistance. Worth 25/-. **Our price, 12/6 each.**
16. Filter Chokes, 80ma, 30 henry, 500 ohms DC resistance. Worth 49/6. **Our price, 13/6 each.**
17. Output Transformers, 30 Watt, 6,600 C.T. to 500, 250 ohm line. **32/6 each.**
18. Output Transformers, 10 Watt, 9000 C.T. to 500 ohm line. **Price only 14/9 each.**
19. Line to Voice Coil Transformers, 500 to 12.5 ohm. Worth £2 each. **Our price, 7/6 each.**
20. Line to Voice Coil Transformers, 1000, 500 line to 3 ohm. Worth £2 each. **Our price, 12/6 each.**
21. Split Stator Condensers, ceramic insulation, heavy plates, ⅜ inch insulated shaft, maximum capacity, 60 uufd. **Price only 7/6 each.**
22. 2 Gang H Condensers. Worth 27/6. **Our price, 15/-.**
23. 3 Gang H Condensers. Worth 36/9. **Our price, 19/6.**
24. 2 Gang Double Spaced Variable Condensers, ceramic insulation, ⅜ shaft Capacity 10 to 70 Pf. **Price only 9/6 each.**
25. Double-spaced Transmitting Condensers, ceramic insulation, capacity 30 to 350 Pf. **Price only 10/- each.**
26. 2 Gang Condensers, Standard BC type, match A.W.A. Dial, ceramic insulation, 11-430 Pf. capacity. Worth 30/-. **Our price, 12/6.**
27. 1 Gang Condensers, as above, suitable for Crystal Sets. **A bargain for 9/6 each.**
28. Standard Type English Magnetic Pick-up. Light weight. Brand new and Boxed. Worth 45/-. **Our price, 30/- each.**
29. 4mfd 350 Volt Electrolytic Condensers, Pigtail Type. New and Perfect. Worth 4/4. **Our price, 2/- each.**
30. Short Wave tuning coils, Iron Cored, 16-50 meters Aerial, RF and Osc. Brand new. **Price only 1/3 each.**
31. Ferroxcube Rod Aerials, ideal for Portables, takes the place of a loop, equal to 60ft Outdoor Aerial. **Price only 16/6 each.**
32. 3 Speed Gramo-Motors with High Fidelity turnover crystal pick-up and two Sapphire Needles, ideal for both Standard and Microgroove Recordings. Automatic Stop. English Make. **Price only £8/19/6.**
33. Electric Shaver Packs. These Units connect to a 6 Volt Battery and give any AC DC shaver, such as Philishave, Shavemaster, Remington, etc. Brand new and Guaranteed. Worth £8/15/. **Our price, £4/13/-.**
34. Speaker Windings. All types available. When ordering, state type of Speaker and impedance required. **Price only 3/6 each.**
35. Rheostats, 250 ohms, 25 Watt. Mica and Porcelain Insulation. **Price only 4/6 each.**
36. Rheostats, 100 ohms. **Price only 2/3 each.**
37. Midget 2 Gang Condensers, suitable for Broadcast Receivers, Small Portables, etc. Worth 19/6. **Our price, 9/6 each.**

SPECIAL NOTICE

All parcels sent Registered Post unless otherwise stated. Postage or Freight must be included with order.

547 ELIZABETH ST., MELBOURNE ALSO AT — ALBURY ARARAT BAIRNSDALE BALLARAT BENALLA BENDIGO BROKEN HILL COLAC DANDENONG ECHUCA SALE FRANKSTON GEELONG MILDURA SHEPPARTON ST. ARNAUD WAGGA WANGARATTA WARRAGUL

Only one contact on each band with any one station per twenty-four hours commencing midnight EAST is to count for scoring purposes.

Exchange of a serial number will constitute a contact.

Serial numbers are made up of five figures for telephony and six for CW, as for other WIA contests.

Scoring — points allotted apply to each band worked.

Interstate and overseas contacts: 5 points for the first contact with any particular station, 4 points for the second, and so on to the fifth contact for 1 point after which no more scoring contacts with that particular station can be made on that band for the duration of the contest, e.g. VK5ABC may work VK2XYZ five times on each of the four bands for a total of 20 contacts.

Intrastate contacts (for VK call areas only).

1. Five points for the first contact with any particular station, four for the second and so on as for interstate and overseas contacts.

2. Stations located beyond a radius of 100 miles of any capital city (Federal Capital excepted) will double their score for all contacts.

Logs containing full information should be received by the Federal Contest Committee, Box 1234K, GPO, Adelaide, South Australia, not later than March 1, 1956.

Awards: The outright winner of the contest within the Commonwealth of Australia will receive an appropriately inscribed certificate.

The leading financial member of the WIA will hold the Ross A. Hull Memorial Trophy for a period and will receive an appropriately inscribed photograph of the trophy.

The highest scorer in each call area in Australia and New Zealand will be awarded a certificate.

A certificate will also be awarded to the AOCP licencee who gains the highest score in each call area.

DOUG—VK5BY

Among the older (in experience) amateurs in South Australia and still active is Dougall Whitburn, VK5BY, who still pounds a key at high speed.

Dougall was prominent in WIA affairs in that State. From 1927 to 1932, he held various offices ranging from assistant secretary to president of the Division. Since then he has been a "back-bencher" although he has assisted in many ways through the years.

Most of his operating time is spent on 14 mc/s and a similar percentage of CW. 3938 mc/s is used for local rag-chews, where 16 elements produce the required signal.

The main interest, however, is chasing "ratties" and with that point in view most of the available time is spent listening on 14 mc/s. When the tally is 213 countries there is a big time gap between new ones and listening also conserves the power wasted with useless calls.

Recently Dougall was elected a member of the FOC, England, the only other members in VK-land are VK3FH, VK4FJ, VK6EJ and VK4YP. He is always very pleased to contact his old friends via amateur radio. If you don't hear him about he is probably just listening for the 214th country, or possibly reading someone's mail.

CONTEST FOR QRP

THE QRP Society, an RSGB group, conducted a world-wide constructional contest that concluded in September. Opposed to the normal run of operating tests it covered constructed equipment for lower power only.

The QRP Society will award certificates to the successful entrants whose descriptions of their equipment are adjudged the best.

The contest was divided into four classes:—

Class A: For hand carried portable receivers (up to 3lb), transmitters up to 5lb and tranceivers up to 7lb.

They must be dry battery operated, weights exclusive of batteries, phones, key, antenna. Economy of battery consumption, lightness, compactness, versatility and ease of operation will be considered.

Class B: For mobile transmitters, receivers, transceivers up to 10lb maximum weight exclusive of batteries but inclusive of vibrator unit as required.

Class C: For tranceiver sets up to 2lb weight exclusive of auxiliary equipment.

Class D: For portable test equipment of any type such as wavemeters, signal generators, &c. All must be amateur built, battery operated and truly portable.

The contest, arranged to encourage the development of low-power and portable equipment, is a change from the normal run of events available for entry by radio amateurs, and offers many ideas for similar contests in this country.

BEAR HANDY TAPE HAS LIMITLESS USES

From attic to basement, from front porch to back door, you'll find countless uses for "BEAR" brand HANDY TAPE. Any professional painter or carpenter will tell you what a blessing it is to any handy man or woman.

Made by BEHR-MANNING (AUST.) PTY. LTD., LIDCOMBE, N.S.W.
Also Manufacturers of Bear Transparent Tape, High Quality Sandpapers and "Proofkote"

016C

SURPLUS

512 Elizabeth St., Melbourne, C.1.
Phone: FJ5904. Just 4 doors

Mail Orders Carefully Packed
Please add Freight or Postage

STUDENTS' BRAND NEW MICROSCOPES

THE IDEAL XMAS GIFT

Not a toy. A real Microscope. Hours of enjoyment for any boy or girl Student.

3 Turrets
3 Magnifications.

£4/19/6

100-200 and 300 times magnification

BINOCULARS. BRAND NEW. VERY POWERFUL

Complete in solid pig-skin leather case.

£7/15/-

Fitted with High Class Coated Ground Lenses.

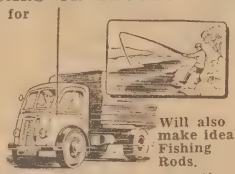
BRAND NEW LEVER TYPE GREASE GUNS WORTH £4/19/6

47/6

Ideal for all types of Trucks, Tractors or Cars, 7500lb pressure.

STEEL ARMY TANK AERIAL RODS WILL MAKE IDEAL RADIO AERIALS FOR CARS OR TRUCKS

Too long for postage. Advise nearest railway station. Bases to suit Aerials, 12/6 each.



Will also make ideal Fishing Rods.

12ft long, 3 sections. Each section 4ft, 22/6. 8ft long, 2 sections, 15/-.

ARMY SPOTTING TELESCOPES

Many uses on the farm. Ideal for Sheep Spotting.

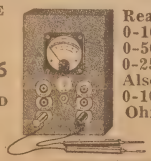
Useful on the rifle range, 3 draw 17in long, 6in closed, 1in object lens, 18 magnification. Made in England . . . .
New Reduced Price **£7/15/-**

AIR MIN MULTI TESTER

COMPLETE WITH TEST PRODS

£5/17/6

TESTS, OHMS AND VOLTS



Reads
0-10 Volts,
0-50 Volts.
0-250 Volts
Also
0-10,000 Ohms.

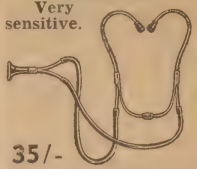
BALL AND SOCKET INSPECTION MIRRORS

8/9

Ideal for mechanics, radio repairs.

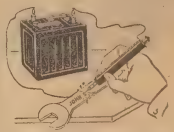
MECHANICS' STETHOSCOPES

Ideal for Testing Engines, etc.
Very sensitive.



35/-

AT LAST THE ELECTRIC ENGRAVER THAT WORKS OFF ANY 6 OR 12 VOLT CAR BATTERY



29/6

Complete with Instructions

Engrave your own tools, name plates, dog collars, cutlery, watch cases, cigarette cases, etc. Engraved articles are never stolen.
Agents wanted for Interstate and all Country Towns. Write for details

ENGLISH SMITH 8-DAY CLOCKS

As used by the R.A.F.

Luminous Dial

£5/15/-

Makes ideal car clock

Fitted with Sweep Second Hand Ideal for any car or truck.

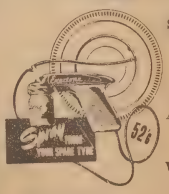
24-VOLT MOTOR COMPLETE With Fuel Pump

Ideal for Caravans. Takes the place of Hand Pumps.

£5

Each.

Many uses on the Farm. Will Transfer Petrol or Any Liquid from Drums, etc.
Will work from 24 or 32 volts AC or DC.



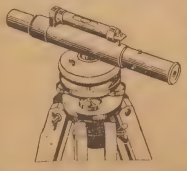
Spray YOUR CAR, TOYS, HOBBIES, FURNITURE

52/6

Spray from your Spare Tyre. An ideal Tool for touching up damaged paintwork. Will spray Lacquer Paint, Enamel.

BRAND NEW SURVEYOR OR BUILDERS' DUMPY LEVELS

Fitted with high class Telescopic adjustable level.
All spare parts available.
Complete with wooden carrying case and adjustable wooden tripod.



Never before at this price

£36/10/-

complete.

Replace those broken side curtains with cellulose acetate which takes the place of celluloid and lasts four times longer. Will not discolor.

32/6 SHEET

Non-inflammable acetate sheet is recommended for all types of side curtains. Sheets are 20 thousandths of 1 inch thick. Size of sheet, 24in x 52in. Can be sewn or cemented into frames.

ARMY FOCUSING TELESCOPE

Easily converted for use on dumpy levels. Can be used as a rifle sight. Excellent magnification — £4/19/6
Fitted with cross hair.

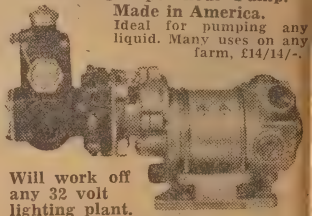
ADJUSTABLE FOCUS.

English Motor and Blower, 24 volts. Will work off any Lighting Plant.

39/6

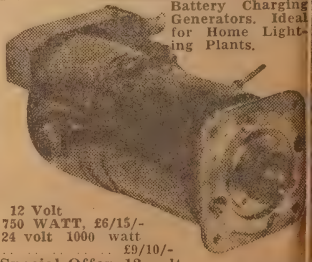
Large size also available that will work off 12 or 24 volts, £3/15/-.

Aircraft 24 volts Motor complete with 400 gal. per hour Pump.
Made in America.
Ideal for pumping any liquid. Many uses on any farm, £14/14/-.



Will work off any 32 volt lighting plant.
Pump only, 55/-.

Battery Charging Generators. Ideal for Home Lighting Plants.



12 Volt
750 WATT, £6/15/-
24 volt 1000 watt £9/10/-
Special Offer. 12 volt 500 watt 59/6
in good working order.
200 amp Generator. Ideal for welding. Made in America.
Brand new £40

STORES

512 Elizabeth St., Melbourne, C.1.
from Victoria Street. Phone FJ5904.

and Efficiently Despatched
Include State in Address

LUCKY PURCHASE
GENUINE R.A.F.
RUBBER DINGHIES
BE EARLY. A FEW ONLY
£8/15/-

SPECIAL DISPOSALS METER OFFER

0-3 amp meters, AC-DC, 2½in dial 45/-
0/1 milliamp, 2½in dial 37/6
0-500 microammeter 3½in dial D.C. moving coil .. 55/-

English 50-0-50 Ammeters, M/Coil 37/6
English 0-50 Ammeters, AC-DC .. 42/-
English 0-40 Voltmeter, M/Coil .. 25/-
English 0-300 AC-DC Voltmeters .. 55/-
English 0-5 Milliammeters, 2½in 27/6
English 0-10 Ammeters, 2½in dial, Moving Coil 45/-
English 0-30 Voltmeters, 2½in dial, AC-DC 42/-
English 0-40 Ammeters, 2½in dial, AC-DC 42/-
English 0-30 Ammeters, 2½in dial, AC-DC 45/-
English 0-14 amps AC-DC 4½in dial, 59/6
Eng. 0-20 amps, 2in dial, M/c 25/-
Eng. 0-1½ Milliamps, 2in dial, M/c, 19/6
Eng. 0-200 Ammeter, M/coil £4/10/-
Eng. 20-0-20 Ammeter, M/coil .. 37/6
Eng. 0-30 Amps AC-DC 2½in dial 42/-
Eng. 0-50 Amps AC-DC 3½in dial, 75/-
Eng. 0-80 Amps AC-DC 3½in dial, 75/-
Eng. 0-1 Amps DC 2½in dial 35/-
Eng. 200 Amps AC-DC 3½ in .. £4/19/6
Eng. 0-5 Amps AC-DC 2½in 45/-

At last the spotlight you have been waiting for.

Fitted with genuine American sealed beam globes. No motorist or boat owner should be without one. 6 Volt, 90/-; 12 Volt, 95/-. Complete with Switch and Flex.

Ideal for Fox or Rabbit Shooting.

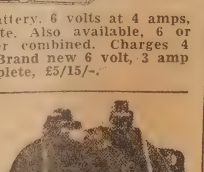
COMPLETE BATTERY CHARGER

Fitted with Brand New English Selenium Rectifier.

Works off 230v. Household Supply.

Charges any battery, 6 volts at 4 amps, £6/15/- complete. Also available, 6 or 12 volt Charger combined. Charges 4 amps, £7/15/-. Brand new 6 volt, 3 amp Chargers, complete, £5/15/-.

VACUUM or AIR PUMP



Builds up air pressure to 90lb at 1000 R.P.M. develops up to 20lb of hydraulic pressure, will pump 7½ gallons S.A.E. oil or other liquids per minute. Useful for spraying, milking, pressure oil burners, hydraulic systems, **£3/10/-.**

ENGLISH ARMY SPOTLIGHTS

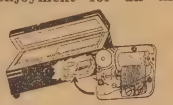
IDEAL FOR SHOOTING FIT ONE TO YOUR CAR.

6-volt, **37/6.**
12-volt, **25/-.**
Fitted with Mirror Reflector.

WATCHMAKERS AND INSTRUMENT MAKERS

English Tweezers .. .. .. 6/6 and 5/6
Eyeglasses .. .. 6/6 and 8/6
Extra strong double lens Eyeglasses 15/-
Screwdrivers, set of five 13/9

Now you can make your own music box with these Swiss music units. They can be fitted to any type of box, doll, jug, teddy bears, etc. Hours of enjoyment for all the family.

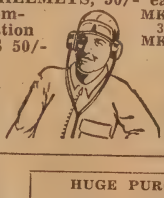


30/-
EACH

Tunes available, Lili Marlene, Jingle Bells, Blue Danube, Harry Lime Theme, Wedding March, The Merry Widow, Happy Birthday, Annie Laurie, How Dry We Are, Roll Out The Barrel, Silent Night, Teddy Bears' Picnic. Also available, a few only, double units which play 2 tunes, 50/- each. Miniature Music Units fit cigarette case, Lady's Compact, etc., 39/6, also 230 vol. Music Unit, works continuously, 59/6.

R.A.F. LEATHER FLYING HELMETS, 50/- each.

Intercommunication TUBES 50/-



MK7 Goggles 37/6 Pair.
MK8 Goggles 48/6.

Polaroid Goggles 48/6.

WOOL LINED FLYING BOOTS. £5/19/6 pr.

HUGE PURCHASE
Waterproof Flying Suits.
Special Price £4/7/6.

Dalton Computors in good working order, 50/-.

JUST ARRIVED TELESCOPES

Latest Model, complete with Tripod.

Achromatic Coated Lens.

£9/15/-

Ideal for Shooters.
25 Magnification.

Not secondhand.
BRAND NEW ENGLISH G.E.C. RECTIFIERS

Make yourself a Battery Charger.
12v 2 amp .. 32/6
6v 5 amp .. 50/-
12v 3 amp .. 45/-
6v 2 amp .. 24/6
6v 4 amp .. 45/-
12v 5 amp .. 79/6

Transformers to suit above Rectifiers. 2 amps, 39/6; 6 volt, 5 amps, 45/-; 12 volt, 5 amps, 55/-.

Brand New American Wobble Pump, semi-rotary.

Continuous flow, £3/19/6

PHOSPHOR BRONZE VANES

Ideal for caravans, emptying or filling petrol tanks, watertanks, etc.

BINOCULARS BINOCULARS SPECIAL OFFER For 1 MONTH ONLY

Here is your opportunity to dispose of those old opera or out of date field glasses regardless of their condition as part payment on a modern pair of 7 x 50 or 10 x 50 high powered pair of binoculars as used by the broadcasters. These glasses are complete with a genuine pigskin case and are priced at the amazingly low figure of £23/15/- for 7 x 50 or £25/15/- for 10 x 50. There is no catch in this offer. These binoculars are brand new and are of the finest quality. Don't miss this opportunity. Remember the Olympic Games are to be held in less than 12 months' time. Just mail your old glasses to us with your remittance for **£18/15/-** or **£20/15/-** for the extra high powered 10 x 50, plus 8/- extra for reg. post.

Hiking Compasses to wear on your wrist, complete with strap, **10/6.** Make your own spot light, 12 volt 100 watt aircraft Headlight Globes, **10/-.** American Schrader tyre pumps, work from your spark plugs, **39/6.** Car type fire extinguisher. Every car should carry one. Cost £7/10/-, **£4/10/-.** Brand new 7/8in spark plugs, suit most old type cars, **2/6,** or ideal for tractors. S.A.E. or Whit. Spanner Sets, open one end, ringed the other. 6 spanners to set, **23/6.** Army steel tow ropes, looped ends, **17/6.** S.A.E. open end spanners, 6 to set, **24/6.** Whitworth, 4 to set, **18/6.** 4½in saw blades complete with arbor, ideal for making saw bench with electric drill, **25/-.** German Army marching compasses, work similar to prismatic, **32/6.** Magnifying Glasses, 8 mags., **8/6.** 10 magnifications, **12/6.** 24 volt motor and hydraulic pump, capacity 3½ gals. per minute, **£3/15/-.** New headphones suitable for crystal sets, **17/6** pair Tapped Transformers, 6, 12, 18 and 24 volts, 3 amps, **39/6.** 230 volts input 5 amps at above voltages also available **45/- each.** Brand new American Cutting and Welding Torches **£4/4/-** complete. Army Slouch Hats in good order, **19/6.** Generator Test Meters, 35-0-35 amp meters, 4½in dial, **45/-.** 0-10 volt meters, 4½in dial, **45/-.** Loading Resistors can be supplied to make meter read 10.20 at **12/6.**

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SMITH ENGLISH SUPER CLOCK

MAX. DIA. 5⅜in. DEPTH 3½in.
FACE 4in DIA. OF PLASTIC.
As used in Radiola Clock Radios.

- Sweep second hand.
- Luminous time hands.
- Internal time switch.
- Can be used in a clock radio.
- Can be used to control electric apparatus — jugs — pumps — heaters, etc.
- Switches on 10 minutes before internal alarm sounds.
- Switches off 1 hour later.
- Control unit to permit radio or apparatus to work for up to 60 minutes after setting (bedside radio).
- Only for engineers or serious experimenters. Applications are numberless.
- Self starting—precision made. 220-250 volt—50 cycle.

Price £5/19/6
Plus 4/- Postage.

DECEMBER SPECIALS

All Post Free.

Egg Insulators (porcelain)	6/- doz.
Electric Jug Spirals (1000 watt)	1/- ea.
Quarter Meg Volume Controls (midget)	2/6 ea.
Half Meg Volume Controls (Egan)	3/- ea.
Half Meg Volume Controls (with switch)	5/- ea.
One Meg Volume Controls (with switch)	5/- ea.
Gramo Needle Cups (bakelite)	1/- pr.
Loop Aerials (Aegis), 7in x 5in	5/- ea.
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Rectifiers (selenium), 12v 600 Ma.	7/6 ea.
Morse Keys (PMG type) (plat. contacts)	2/6 ea.
Oak Switches (1 bank 2 pole 6 pos)	5/- ea.
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(all above complete 5K or 7K trans.)	
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(speakers, headphones post free)	

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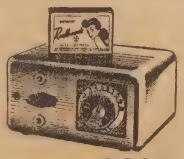

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- GERMANIUM DIODE DETECTOR.
- COMPACT.
- PLASTIC CABINET 5in x 3in x 3in.
- THE MIGHTY ATOM.

EXTRAS:—
100ft Aerial .. 7/6
BROWN'S Sensitive Phones .. 49/6
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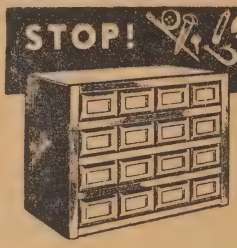
49'6
PLUS 2/- POSTAGE

GERMANIUM DIODE

Type 4A42.

The very finest crystal detector. (Post free 10/-.)



16 DRAWERS
1½in x 2⅝in x 5½in
or 4 Long Drawers
1½in x 10½in x 5½in
IN THIS ALL-STEEL
COLRAD
HANDY CABINET

A craftsman-built unit, attractively painted in baked grey hammertone enamel with provision for fitting identification card on each drawer.

For any other type or sizes, use our FAST QUOTE SERVICE. A strong and most useful cabinet for holding small parts or tools. Ideal for mechanic engineer, garage or home workshop. Provision is made for stacking into units.
OVERALL SIZE 11¾in wide, 9in high 5¼in deep.
Postage: Vic., 3/8; NSW, ACT, SA, Tas., 6/-; Qld., WA, NT, 8/4

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We supply the parts, but cannot enter into any technical correspondence.

FAST QUOTE SERVICE

For quickest possible service, write on the left-hand side of a sheet of paper the radio parts that interest you — one beneath the other. If a kit, itemise. Add your name and address and send it to us with a stamped, self-addressed envelope. We will add the latest prices and return to you. Use this sheet as your order form and return to us with remittance for cost and postage as quoted. Goods will be sent same day. Any surplus refunded. Sorry, no C.O.D.

EVERYTHING FOR THE RADIO AND ELECTRICAL EXPERIMENTER

A COURSE IN TELEVISION

(Continued from Page 95)

Figures 30 and 31 illustrate the general principles of the Vidicon tube. Referring first to figure 31, a very thin, transparent but conductive "signal plate" is deposited on the inner surface of the glass envelope. Over this is laid the photoconductive material.

In operation, a small positive voltage is applied to the signal plate. Meanwhile the opposite surface of the photo-conductive layer is scanned by an electron beam, which deposits surplus electrons upon it. As the net result of these two functions, a considerable potential difference exists between the two surfaces of the photo-conductive layer.

Under dark conditions, the leakage across the layer is very low and very little current flows through it.

However, if a light image is now focused upon it, the photo-conductivity effect allows current to flow, and those portions of the layer which are brightly illuminated acquire a positive charge from the back plate instead of the negative charge which would otherwise be built up on them by the scanning beam.

As the scanning beam passes across the surface of the layer it neutralises the varying charges and produces a fluctuating current through the load resistor. Naturally enough, the current variations are greatest when the beam passes over brightly illuminated regions, where a large positive potential has "leaked through" from the signal plate.

CROSS SECTION

Figure 30 shows the cross-section of the tube in more complete detail. The "wall screen" in front of the target provides a uniform field but does not appear as a mesh in the transmitted picture signal. It therefore does not modify the resolution capabilities of the tube, which are dependent on the screen texture and the electron-optics of the beam.

The Vidicon tube has been progressively refined since its initial release, to the point where it is eminently satisfactory for small scale industrial and military installations.

A recent report indicates that a new half-inch Vidicon has recently been built, showing excellent powers of resolution and operating in a completely transistorised miniature camera.

In commercial television, the Vidicon has not yet become a serious rival to the Image Orthicon, although there seems to be no special reason why it should not ultimately be developed to the point where it will be so. At the moment, the ultimate resolution of the types available is poorer than the Image Orthicon, likewise its adaptability to low or excessive light intensities.

However, the Vidicon is displacing some of the older type television tubes which have hitherto been retained for such non-critical applications as film pickup and slide transparency transmissions. Vidicon "cameras" are being widely adapted overseas for such work.

Mention of film and slide transmission, particularly the latter, brings us to the "Flying Spot Scanner" tube, to which readers may have seen reference in technical literature.

The Flying Spot Scanner is actually not a camera tube, in any sense of the term, although it is used for transmitting transparencies. It is actually rather like an ordinary display tube, except that it is designed to produce an intense, finely focused spot of light on the screen, of very short duration.

This spot of light is deflected in the standard scanning pattern and focused optically on to the transparency to be televised. The action is analagous to the scanning spot, which was produced mechanically in early TV systems, except that the electronic scanner eliminates any problems of scanning speed &c.

The light passing through the transparency is collected by a photocell, transformed into an electrical signal and amplified in the usual way.

The idea is an excellent one for televising still pictures, advertisements, station insignia, &c., because it will produce reliable, high definition signals, with a minimum of equipment.

To be continued.

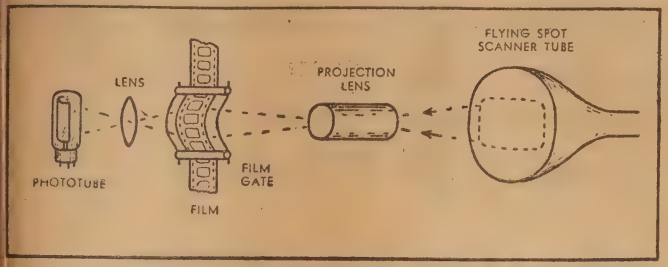

Figure 33: Illustrating the use of a flying-spot scanner for film transmission.

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Glenradio Fluorescent Inverter

(for fluorescent lighting from car batteries)

NOTE THESE FEATURES:

- Low battery drain—improved lighting.
- Small size only 8in x 5in x 5in.
- Completely filtered to prevent radio interference.
- Two ten watt flourescents 12in long may also be used.
- Cold Cathode—instant start units also available.
- Correction condensers and ballast are internal.

Send for free leaflet—state your problems and obtain our advice.

STANDARD UNIT TO OPERATE ONE 20 WATT TUBE—Price 6, 12, 23 Volt input, £12/15/-.

Plus starter fluorescent tube, sockets, channel light, already wired £1/10/-.

NOTE: Other units available for 40 watt—twin 20 watt—twin 10 watt—Single 15 watt, etc.

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PIX Cameras COVER THE WORLD PIX I'-

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HGP38 Hi-g Turnover Crystal Pick-up

Another superb "Acos" Hi-g pickup, designed to give the utmost in satisfaction.

Will track with ease all present-day recordings and those of the foreseeable future, too. Incorporates the HGP37 cartridge with cantilever sapphire styli which features vertical compliance that nullifies "needle talk" as well as increasing lateral compliance.

Cartridge utilises a new method of crystal drive, a bisectional control element that achieves independent characteristics for standard and microgroove.

SALIENT FEATURES

High compliance, hermetically sealed crystal unit,
High output and low stylus pressure.

SPECIFICATION

Output—1 volt on standard records
1/3rd volt on microgroove records
Tracking weight—10 grammes

Price complete with HGP37 Cartridge
£5/15/-

Sole Australian Agents:— AMPLION (A'sia) PTY. LTD. 88 Parramatta Rd., Camperdown, Sydney, N.S.W.

Victorian Distributors:— DISTRIBUTORS CORPORATION 403 BOURKE ST., MELBOURNE.

IATURE ON HE RAMPAGE

(Continued from Page 19)

elievable. In some West Austra- an and Queensland cyclones a ainfall of over 30 inches has been ecorded in a three-day cyclone. The eaviest fall in three days occurred n Mount Molloy in Queensland. his was 63 inches.

/ATER CONTENT

A fall of one inch of rain on an re of ground would amount to 113 ns of water. So that a fall of 30 ches would yield 3390 tons. Yet e amount of water contained in the oud system of a cyclone amounts much more than this, because in easuring the rainfall in a cyclone e high winds prevent more than to 75 pc of the water being caught the gauge.

This enormous amount of water ntained in the cyclone makes it ssible for the radar method to ork.

Radar is a system of very short ectromagnetic waves which are cused in such a way that they can projected in any given direction. hen these waves hit any object ey are reflected back and by serving the time taken for them return to the sending point the stance of the object from the server can be calculated.

RECTION AND SPEED

Likewise by keeping the beam of gnals trained on the object, its rection can be followed and its eed of approach or recession cal- lated instantaneously.

Thus the rain in the cyclones is a nvenient object to reflect radar aves. The beam is focused on the clone. It is reflected back. The stance is calculated. The course of e cyclone can be followed, whether is receding or approaching and if how fast. The intensity can be lculated.

By using different wavelengths, dar can be used on clouds to gain similar result, but by far the most ccessful method has been by the e of radar on rain.

Thus science has again wrought weapon to aid man in his fight ainst mighty enemies, the cyclone d the hurricane.

VHY GRAMO MOTORS IRE NOISY

(Continued from Page 63)

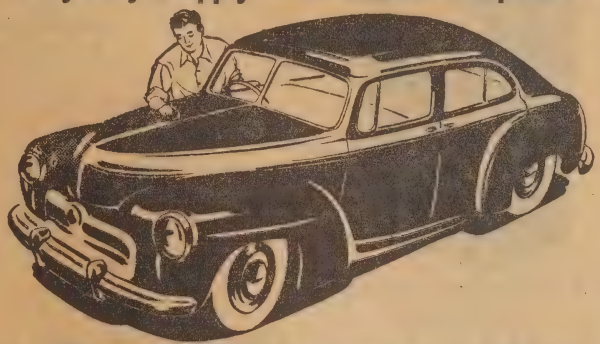
hey not only pass through the stator d into the turntable unit, but also rough the rotor, along the shaft to the stepped roller or other drive, rough the rubber wheel into the rntable and finally to the stylus — th the usual unpleasant results.

Motors with a strong field may o radiate a strong external "leak- age" magnetic field which contains all the harmonic and pulsating components and can, under certain conditions (a poor position for the motor or lack of shielding) induce hum voltages directly into the coils of some magnetic pickups.

It can be seen then, that many factors have to be taken into consideration in the design of a high quality turntable. Choice of motor, method of support or suspension, type of drive, acoustic filtering and damping, constancy of speed and mechanical accuracy are all highly important, if we are to hear our recorded music to best advantage, and it can be both surprising and gratifying to hear how well it sounds when a good quality turntable is used.

Paint Your Car For 70/-

with Sapphire Factory Finish Type Car Enamel
No Brushing — No Spraying — No Masking
Very easy to apply — No streaks or lapmarks



Get beautiful high gloss mirror finish that looks like a spray job

It's amazing! No brushing or spraying required. Sapphire Enamel will make your car gleam like new. This wonderful free flowing enamel is applied with a special applicator which is far superior to brushes. Dries dust free in one hour without a brush-mark, streak or lapmark. No undercoat to apply.

Sapphire Enamel is the result of a new formula perfected after years of research. It flows on so smoothly without leaving a single blemish. No previous experience is required, because it's so easy to use. No need to remove the old enamel or lacquer. Simply clean the car then wipe on Sapphire Enamel. The special applicator wipes the enamel on so mirror smooth, so easy that you'll be delighted with the brilliant new look of your car. One quart is sufficient for painting a car, and one coat covers any other enamel or lacquer.

28 smart, popular colours for you to choose from. Whether your car is an old or late model, Sapphire will give it that high gloss like-new appearance . . . and not a single brush-mark marring its surface.

Sapphire Enamel is guaranteed not to crack, fade, chip or peel for two years. Your money refunded without question if Sapphire does not live up to this guarantee.

Sold only by Pacific Auto Supplies, sole distributors for Sapphire Enamel. Send now for a quart of Sapphire Car Enamel. Special applicator and instructions, price 70/- plus 6/- extra for postage and packing. Mark your colour choice on coupon below. Post your order at once, so as not to miss this opportunity. Send TODAY.

FREE As a special gift to Radio and Hobbies readers we are giving, absolutely free, six brand-new spark plugs with all Sapphire Enamel ordered during the next 30 days.

Post Coupon Now — Hurry! This offer is limited

Pacific Auto Supplies, Dept. 8-24, 47 McLeod Road, Carrum, Victoria.

Enclosed is ..... Please send immediate delivery..... quarts of Sapphire Enamel, special applicator, 2-year guarantee and 6 free spark plugs. Sorry, no C.O.D's.

My car is a ..... Year .....

Name .....

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28 POPULAR COLORS: Mark Your Choice.

White.	Dove grey.
Off-white.	Dark grey.
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Cream.	Cherry red.
Light cream.	Russet red.
Rich cream.	Maroon.
Light stone.	Dark maroon
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Fawn.	Sky blue.
Pastel green.	Light blue.
Light green.	Royal blue.
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Dark green.	Yellow.
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NEW BRANCH

636 KING ST., ST. PETERS

The 2 Largest and Finest Stocks of Disposals Radio Equipment in Australia. Now side by side.

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DULWICH HILL, UNDERCLIFFE, EARLWOOD

EVENINGS and WEEKENDS: "KALUA",

AR8 COMMUNICATIONS RECEIVER

12 Valve. Converted to 240V A.C. Thoroughly Tested. Re aligned. Latest Ovaltone Permag Speaker. Noise Limiter added.

£34/17/6

NEW — RT34 APS13

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12 Valve, 420 Meg Transmitter Receiver Gene Powered 5-UJ6, 9-UAG5, IVR150 2-2D2 Complete with Circuit and Conversion Circuit.

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NEW VALVES

1C6	12/6	723A/B	
1D4	12/6	KLYSTRON	£3
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1K4	12/6	12SJ7	12/6
1K6	12/6	12SK	12/6
1LH4	12/6	12SL7	12/6
1LN5	12/6	38	12/6
1P5	12/6	39/44	10/-
1R4	12/6	46	12/6
1V	12/6	47	12/6
2A6	12/6	78	12/6
3A4	15/-	304H	£5
3B7	10/-	809	£2
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KTW62/6U7	7/6	NR74	7/6
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Transmitter-Receiver, Aerial Coupler, Cables, Plugs, Phones, Mike. 1 Crystal to desired Frequency. 24V Power Supply & Circuits of 3 units GUARANTEED IN PERFECT ORDER.

£62/10/-

Other voltages available.

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New ROLA 3-inch SPEAKERS

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COMPLETELY RECONDITIONED With 5-coil boxes. Perfect order.

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BENDIX

BC221 FREQUENCY METERS, AIR TESTED Original Crystal and Calibration Book

£45

NEW C.R.O. TUBES

VCR.138 .... £2/2/6

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Connections & Basic Circuit included

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American 7 Strand Rubber Insulated ½ MILE DRUMS 15/-

CASE OF 6 DRUMS, 3 MILE £4/-/- DON 8 WIRE, 3 MILE £10/-/-

Throat Mikes, new 3/6

12v 420 watt Prefocus Globes 7/6

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150 WATT 24 to 32V DC Input 230V AC 50 Cycles Output

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TSC6 TRANSMITTER & RECEIVER

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Power Supplies available for various voltages. Prices on application.

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20 Watt 6600 P to P to 600

£2/5/-

TRIMAX INPUT TRANSFORMERS

600 togrid. Triple shielded

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TYPE S POWER SUPPLIES

FOR AR8-AT5 STATION 240V AC operation. Air tested

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60 pf with Vernier .. .. £1/1/- 30 pf 10/-

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Complete with valves and Circuit

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unt your Mobile Gear Amplifiers, etc., these 11 x 8 rubber and steel shockers.

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12 Volt
For Signalling, Shooting, Yachtsmen, etc.,

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SMALL FULLY-SHIELDED 2500V
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12V 1200V 200MA	6	10 0
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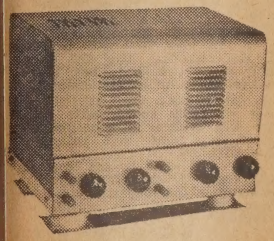

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ANSWERS TO CORRESPONDENTS

C.J.J. (Adelaide, SA) is very interested in the current series on transistors and transistor sets and wants to know if we can supply details of a transistorised personal portable suitable for camping, hiking, &c.

A.: Sorry C.J.J. but, as we explained in one of the earlier articles, it isn't as easy as all that; we only wish it was. The transistors at present available on the Australian market are of a type (junction type) which have yet to be developed to the point where they are suitable for operation at radio frequencies. At present their efficiency, even at broadcast frequencies, is poor. As a result, we have to be content with simple sets which rely mainly on audio amplification for whatever gain they provide. Even the humble regenerative detector is not yet a proposition. On top of this is the need for components for use with these devices. Not only must they be miniaturised if full advantage is to be taken of the transistor's small size, but they must also provide the correct impedances, which need to be much lower than those used for valves. In the light of all this, it will be seen that there is no easy solution, at the moment, to the problem which is worrying not only yourself, but many other people as well. You may rest assured that as soon as the supply position is favorable we will attempt something along these lines. Many thanks for comments and criticisms about the magazine, which have been noted. While we are aware of some of the points you raise it is not possible, at present, to do anything about them. However, we will certainly keep them in mind.

R.G. (Bexley, NSW) asks us what is a volume expander and its method of operation.

A.: A volume expander increases the level of the loud passages and decreases the level of the quiet passages in the reproduction of recorded music. It was evolved to offset any restriction of the volume range imposed by pre-war recording processes. With the advent of micro-groove recordings, there is less need for such circuits as the records can be made with a much greater loudness range (or to be correct "dynamic range").

The main requirements of the circuit are an amplifier stage which has its bias controlled from a separate amplifier and diode rectifier network. It is similar to an audio AVC system but working in the reverse direction.

I.M. (Rupanyup, Vic.) wants to know if we have ever described how to construct a small electric motor of the type which may be operated from dry batteries.

A.: A constructional article along the lines you require was published in the February 1952 issue. Unfortunately we have no copies of this issue available but you may be able to borrow a copy or refer to it at your nearest public library.

L.G. Mc. (Newport, Vic.) has built the Set for Young DXer's and has added a 6V6 as an output stage. He now finds that it is not possible to use maximum reaction on short waves without suffering interference from commercial stations.

A.: Unfortunately you have given us no details of the interfering station, such as the proximity, strength and whether it is confined to one or several. Without such details it would be difficult for us to help. However, it seems unlikely that this effect has been aggravated by the addition of the 6V6, since this would have no effect on the operation of the detector. We suggest you try reducing the length of aerial which will often function quite efficiently, when much shorter than the one you are using, but be better able to reject the unwanted signals.

G.N.S. (Wallington, Vic.) writes in appreciation of the magazine and asks if he could use the valve types 6D6, 42, or 76 in the Set For Young Dxer's described in October, 1954.

A.: No, G.N.S., none of these valves would really be suitable. The valve type required is a high-gm RF pentode and possible one of the disposals type valves could be used. Suitable types would be VR65 or the VR91.

H.A. (Braybrook, Vic.) sends us a circuit of a transistor set he has made but which he cannot tune satisfactorily.

A.: You seem to have things a little tangled, H.A., and it is not surprising that the set is not satisfactory. To tune the set it will be necessary to employ a tuning capacitor exactly as with any other type of receiver. The use of the transistor as in your circuit is also somewhat unusual and offers little more than would be obtained from a simple crystal set. We can only suggest that you refer to the transistor set described in the May, 1955, issue, the circuit of which should answer most of your questions and provide a satisfactory basis for future experiments.

I.H.G. (Surry, Vic.) wants to use the front end of the 3 Band Receiver of December, 1954, ahead of the 17 Watt Ultra-Linear amplifier and No. 6 Control unit, but is a little unsure as to where to break the circuit.

A.: The audio signals of the tuner portion of this receiver will be picked off from the diode load; in this case the .5 meg. pot. Since a control may not be needed here it could be changed to a similar value of resistor. We are glad to learn that you have had so much success with the Amplifier and Control Unit and trust that this latest venture will be equally successful.

I.S.J. (Port Kembla, NSW) writes to tell us that he has built the Modulated Oscillator and the Signal Tracer and has supplied the B-plus to both of them from a common rectifier system. He is having trouble with the output of the oscillator being coupled into the signal tracer.

A.: The circuit that you show in your letter of an RF choke and a 16 mfd condenser to decouple the B-plus from the common supply to the signal tracer is open to some criticism. Firstly the RF choke, the details of which you give, may not be effective at all frequencies in the band. A resistor of, say, 1000 to 1500 ohms might be better. Also an electrolytic condenser is unsatisfactory for decoupling at high frequencies as it has a large inductive reactance in this frequency range. To cover this it should be paralleled with a mica condenser of some value about .001 mfd. The common coupling m not be only through the supply lea and some shielding of the two instr ments from each other may be nece sary. All this points to the fact th we have mentioned in many letters readers and through these columns th it is not a good policy to make ea item of test equipment anything but complete and separate unit from a other equipment. The apparent inity saving is more than offset by inte action effects and the difficulties whi arise if at a later date it is desired make a change in one of the pieces equipment.

H.F. (Cheltenham, Vic.) sends in a ci cuit for a push-pull output stage witho a conventional phase inverter.

A.: The circuit arrangement certain works and is a well-known one. In fac it was used in several PA amplifie published in this magazine some yea ago. Its action depends on a voltag being developed across the resistor the screen lead. This voltage is out phase with the driving voltage an when applied to the grid of the secon valve, gives the voltage necessary drive it. The developed voltage depend on the value of the resistor and is, there fore, fairly critical. An incorrect valu would cause unbalance of drive, an consequent distortion.

H.F.F. (Bundaberg, Q.) writes us very interesting letter on his experience with dual wave coil brackets in the I and H. Dual Wave Battery Five de scribed in the June, 1951, issue. H reports that he has excellent result with the set and uses it to feed a 12 speaker.

A.: Many thanks for your letter, H.F.F and we are glad that you are please with the results. The use of a 12 speaker is an excellent idea where yo have the space to accommodate it.

U.G. (Melbourne, Vic.) asks us for ad dresses of radio spare parts manufac turers and where information can b obtained on radio and resistors an voltage dividers.

A.:—We feel that letters sent to an of the radio components manufacturer advertising in the magazine should resu in your obtaining all the information tha you require.

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All queries concerning our designs, to which a POSTAL REPLY is required must be accompanied by a postal note or stamps to the value of TWO SHILLINGS.

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Whatever the subject matter, we must work on the principle that a letter is too involved if the reply takes more than 10 minutes of our time.

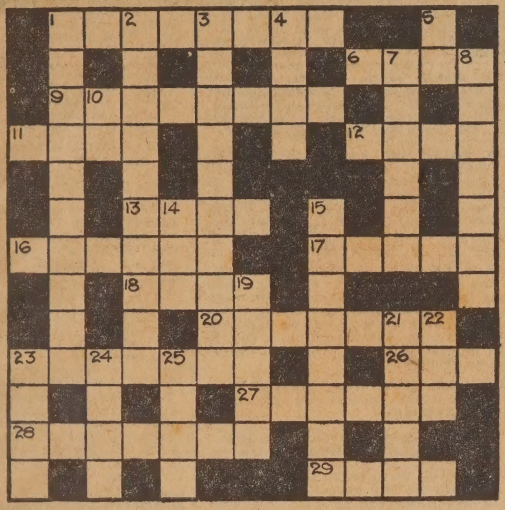
Queries not accompanied by the necessary fee will be answered FREE in the columns of the magazine and presented in such a way as to be of interest to other readers.

To those requiring only circuit reprints, &c., we will supply for TWO SHILLINGS diagrams and parts lists from our files covering up to three constructional projects. Scale blueprints showing the position of all holes and cut-outs in standard chassis can be supplied for 5/-. These are available for nearly all our designs but please note they do NOT show wiring details.

Address your letters to The Technical Editor, RADIO, TELEVISION and HOBBIES, Box 2728C, GPO, Sydney.

Note that we do not deal in radio components. Price quotations and details of merchandise must be obtained direct from our advertisers.

THE R. & H. CROSSWORD No. 20



ACROSS

1. Type of frequency changer
6. Unit of current (pl.)
9. A Metallic Element
11. Prefix meaning half
12. Looking with side glances
13. French word for head
16. Australian timber wood
17. Prefix meaning beyond
18. Smallest particle of an element
20. Antenna with two elements
23. English comedian
26. Middle
27. Turntable speed-checking device
28. Five-element valve
29. Wanting Light

DOWN

1. Device for control of signal level
2. Another phrase meaning interrupted continuous waves (2 words)
3. Describing a ray of positive ions
4. A part of speech
5. Aloft
7. Device with property of attraction
8. Varnish base
10. Amplitude Modulation (abbrev.)
14. To take food
15. Enumerated
19. Type of code
21. Hot cinder
22. Bond
23. Used in magnetic recording
24. Charged atom
25. Entrance of a house

Solution and further crossword next month

SIMPLE 2-VALVE RECORD PLAYER

Continued from Page 101

en or closed. A possible difficulty when speaker and pick-up are unted together is that acoustic dback may occur between them.

Quite frankly, for bass response capable of rattling windows down the street you will be forced to mount them separately. However, in most cases the performance will be quite satisfactory if you take care to see that the flexible mounting between the motor base and the board is working correctly. The response of the pick-up does fall off a little toward the low end which helps to make the position workable.

Yet another suggestion you may be able to work on is that the speaker be mounted on the lid which could be removable. This assumes a fairly deep cabinet, say one intended for a record changer or possibly one you could make yourself. Special provision to protect the speaker both from dust and from sundry damage due to careless fingers is necessary and wire mesh covered by a strong cloth is often used in such cases.

	R	E	Q	U	E	N	C	I	E	S		R		
	L			N				N	A	P		O		
	E	M	I	T				T	R	Y	S	T		
	I	C	R	O	W	A	V	E	S			O		
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	G	O		E		T	U	N	I	N	G			
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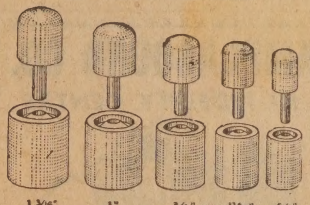

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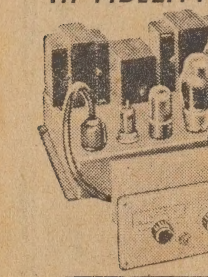

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SELL: New goldring var. reluct. pickup and No. 6 control unit. Sell at cost of parts. Perf. response. FU7479.

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SELL: Amplifier 6 watt full treble and bass controls. I cannot tell difference between this amplifier and costly amplifier. Any trial £25 also TL10. Leak as new under guarantee £50. 5 Napier St., Lindfield. N.S.W.

SELL: Australian Sound Systems 5 Valve D/W, 6V Vibrator radio, spare set valves and vib. cartridge perfect condition. Snap £10. D. Dettrick, c/o Fairymead Sugar Co., Bundaberg. Qld.

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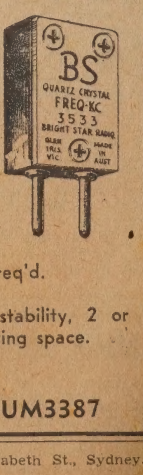
We are pleased to announce that in addition to our other lines of crystals, we are now manufacturing

Vacuum Mounted Crystals

for general communication frequencies in the range 3—14M.C.—Higher frequencies can be supplied.



Price depends on the tolerance and frequency req'd.

Quotes on Request.

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